# FARLOWIA

## A Journal of Cryptogamic Botany

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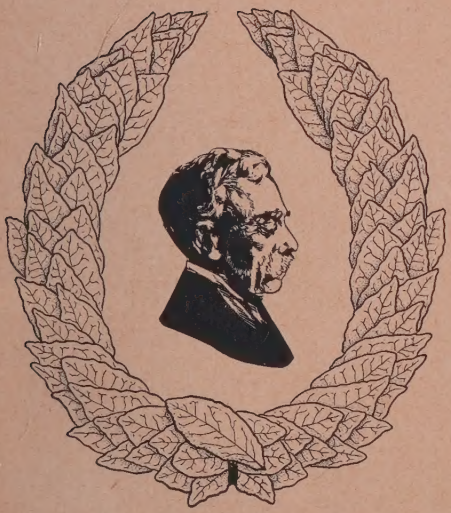

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# FARLOWIA

A JOURNAL OF CRYPTOGAMIC BOTANY

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## FOREWORD

The question may be raised: Why have a journal for taxonomic cryptogamic botany? To those who query the desirability of inaugurating a periodical of this description, the following brief answer is offered. Those who have been interested in cryptogamic botany in its taxonomic aspects have long recognized the need of monographic studies, either taxonomic, morphological, cytological, or ecological, which might contribute to the systematic arrangement of the many and diverse groups of organisms which constitute the non-vascular cryptogams. Likewise it is evident that taxonomy is the keystone of all biological studies since it provides the investigator in other fields of endeavor a label for the specific unit of plant life that is being studied, thus making it possible for future students to confirm or to amplify the previous investigations. The stability of the name employed to label the organism depends to a great extent on the thoroughness with which the special group has been studied, how carefully the older and often imperfect records have been evaluated, how widely acquainted with related groups is the writer, and how well he has incorporated the information that may have been provided by morphology, cytology, genetics, ecology, chemistry and other related fields. Unfortunately, our knowledge is still meager, but on the basis of that which we do possess, it may be stated that accurate taxonomic investigations not only borrow from but contribute to related branches of knowledge. At the same time, it may be said that this discipline is a prime necessity for the validation of results, either from a scientific point of view or, since all knowledge may be of eventual practical value, from the viewpoint of its contribution to human welfare.

Frequently the systematist, through his special knowledge of the organisms that come to his attention, is in a position to save a considerable amount of time for the chemist, the physician, the physiologist, or the bio-physicist since he is able as a result of his taxonomic studies to suggest a single species or a group of species that will satisfy the needs of the investigator in the other fields of research. This contribution is almost wholly forgotten because it is less dramatic than are the results not infrequently secured by those, who without any attempt to belittle them may be called test-tube biologists, who started their studies where generations of taxonomists left off. Many examples could be

chosen from the broad field of cryptogamic botany which would demonstrate clearly the dependence of other branches of biological science on the results of the many years of labor of the collectors and the taxonomists and which would illustrate the value of the so-called useless information. Probably no better example could be chosen than the situation that has arisen as a result of the cutting off of America's supply of agar-agar by the Japanese who with their cheap labor and favorable localities have a monopoly on the harvest and production of the algal material. With the cessation of imports, commercial concerns have turned to the algae of the American coasts for substitutes for the agar that they used in the preparation of hand-lotions, ice cream, and other products. Commercial needs are more easily supplied than are those of the bacteriologists, the public health officers, and the plant and animal doctors who require a substance of rather specific physical characteristics for the hardening of the culture media that they employ for growing the pathogenic organisms which they are studying in an effort to control diseases. It is immediately apparent that agar plays a very important role in the welfare and nutrition of this and allied countries. The acute shortage of this material has made it necessary that substitutes be found at the earliest possible opportunity. Fortunately, as a result of the activities of the collectors, many of whom were amateurs who made the gathering of representative algae a hobby, and of the taxonomists whose studies have made known the morphology and structure of the algae, there is present and available for use, either in the literature or in the various herbaria, a large amount of information that is of immediate value. Those who are today seeking a substitute for the Japanese agar have been spared the large amount of pioneering work that has been done for them, and can turn their attention without loss of time to the analysis of the more likely species.

The above may be considered by some to be an excuse for the continuation of taxonomy, but taxonomists directly or indirectly have made too many contributions to knowledge to apologize either for their existence or their errors. Rather it is intended to prophesy how little credit will be given to the taxonomists and collectors and to emphasize the reason for the relatively small amount of support received by them today. It is this lack of support that has made it extremely difficult for American systematists to publish the longer monographic studies of which there is great need. Part of the difficulties arise from the fact that the papers submitted for publication are in competition with those dealing with current scientific fads or else those having more immediate practical value and they are accordingly judged to be of less importance. The other side of the story is that most journals are published by academies, societies or institutions which for the most part must limit the privilege of publication to their members or staffs, and since the membership is comprised of many individuals with almost as numerous

interests, articles must be limited in number and length in order that all may have a fair opportunity to make public the results of their investigations. To remedy this situation and to make possible the publication of longer taxonomic papers, it has been decided to publish the present journal which for the time being will include articles up to one hundred pages in length and that deal with taxonomy, cytology, morphology and the related fields that contribute to the classification of the non-vascular cryptogams. The first volume will be published semi-annually over a period of two years, after which it is hoped that the uncertainties brought about by the war will be removed and that the support of the journal by cryptogamic botanists will make possible the establishment of FARLOWIA as a quarterly journal. Thus those of us who have enjoyed the fruits of his contributions to the development of American cryptogamic botany by his teachings or through the use of the facilities of the herbarium and library that he had brought together and dedicated to the advancement of this special field of botany, may fittingly acknowledge in 1944 the centenary of the birth of William Gilson Farlow.

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1(1): 5–8 FARLOWIA January, 1943

# THE AIMS OF FUTURE RESEARCH IN THE ALGAE

V. J. CHAPMAN

Since the beginning of this century very considerable progress has been made in our knowledge of the algae. Up to then interest centered, as was perhaps natural, around morphology and systematics, and at the same time compilation of floras proceeded apace. Now, more attention is being given to the ecology, physiology and reproduction of the algae, but these branches are still in their infancy. This change in outlook does not imply that no future progress can occur in morphology and systematics, but it does mean that the greatest advances of the future can be expected to be made in these younger branches. For this reason research in them should be encouraged, though the older aspects should not be neglected since they still offer many problems that remain to be solved.

Morphology and systematics are an essential background to any botanical subject, and the more complete our knowledge of them, the more likelihood is there of sound and substantial advances in other branches. Today one of the most important needs in algal systematics would seem to be a continuation, with greater intensity, of the attack being made upon the smaller microscopic algae, especially the marine forms. In recent years much has been achieved in this direction for soil and fresh-water species and Pringsheim with his cultures (Biol. Reviews **16:** 198. 1941) has indicated the best method to be adopted. Here one may perhaps express a hope that someone will soon publish a book describing all these forms with the provision of a key for their identification. There are still, especially in tropical and sub-tropical marine habitats, a number of species which require investigation and description. One may mention here the encrusting species of all groups: these have been studied fairly thoroughly in Europe and to a somewhat lesser extent in North America. Because they are so inconspicuous and often are not found in fruit, relatively few phycologists have studied them and many are regarded as rare. Persistent search in England has shown that this is not correct and that the majority have a far wider distribution than has been ascribed to them. This will no doubt be found to be true in other countries. Our knowledge of such forms in tropical and sub-tropical regions is exceedingly scanty and the position is not much better in the southern hemisphere.

There are certain genera, such as *Enteromorpha*, which I have been studying for some years, and *Cladophora*, which require to be investigated with a view to monographic treatment. At present it is quite impossible to identify with any degree of certainty some of the Cladophorae, more especially the tropical and sub-tropical forms. Valuable studies of this character have been undertaken by Kylin (Lunds Univers. Arssk. **20:** 1924) for the Delessariaceae in the Rhodophyceae and by

Parke (Hartley Bot. Lab. Pub. **9:** 1933) for the Mesogloiaceae. Even the common species of *Fucus* are in need of further investigation in spite of excellent work upon them by the earlier phycologists, e. g. Sauvageau. The salt marsh forms of this genus are particularly difficult to determine and yet they play an important part in the algal ecology of salt marshes. Numerous varieties of *Fucus* species have been described and it is only by collecting and examining forms from many different localities that their status will finally be determined.

If we turn from systematics to morphology a principal need would seem to be a study of the developmental stages among members of the Fucales. In recent years Delf (Journ. Bot. Lond. **75:** 273. 1937, and **77:** 129. 1939) and her school have done much towards elucidating the development of the reproductive organs in the lesser-known species of this group, but the young stages have been largely neglected, a fact which can be ascribed to the difficulties of identifying them in the field or with growing them in culture. It is important that this problem should be overcome because it is of very considerable significance in ecology. A very valuable start in this direction has been made by Nienburg (Wiss. Meeres. Abt. Kiel **21:** 51. 1931). Culture studies of certain algae have recently forced us to realize that we have not yet determined all those species which have very different forms for their sexual and asexual generations. It has recently been shown (J. Behlan, Beih. Biol. Pflanz. **27:** 221. 1939) that *Chlamydomonas variabilis* and *Carteria ovata* are alternate generations of the same species and also (P. Kornmann, Planta **28:** 464. 1938) that the same applies to *Halicystis ovalis* and *Derbesia marina.* These are comparable to the older classic example of *Cutleria* and *Aglaozonia.* With the improved culturing technique we must re-investigate the life-histories of many species with a view to ascertaining whether they behave similarly. Bliding (Svensk. Bot. Tidskr. **27:** 233. 1933) has shown by such means that two well-marked forms of *Enteromorpha prolifera* are simply two generations of a single species. The investigations of Knight (Trans. Roy Soc. Edin. **56:** 307. 1929), Schussnig and Kothbauer (Oest. Bot. Zeit. **83:** 81. 1934) and Papenfuss (Bot. Gaz. **96:** 421. 1935), which show that *Ectocarpus siliculosus* may have a different life cycle in different parts of the world, lead us to the conclusion that we must not be satisfied with a single study of a life history, however complete it may appear to be. The Chaetophorales is an order for which it is very desirable to have some advance in our knowledge of life cycles and chromosomal conditions. Such knowledge will prove to be of the greatest value phylogenetically.

In physiological studies the greatest advances will probably come from biochemistry, especially studies concerned with the pigments. The classification of the algae is primarily based upon pigmentation and hence the discovery of any unusual features, e. g the phaeophycean pigment fucoxanthin in *Polysiphonia violacea,* in *Zygnema pectinata* and

the Chrysophyceae (P. W. Carter, I. M. Heilbron, and B. Lythgoe) (Proc. Roy. Soc. **128**: 82. 1939), may lead to far-reaching systematic conclusions. Apart from this the rôle of growth substances in the algae has been but little studied and further investigation may show that they play as important a part in algal development as they do in the phanerogams. Most phycologists would now subscribe to the existence of 'sun' and 'shade' algae, but there is not the same agreement upon the criteria that determine to which group any given species should be assigned. Further work upon this problem is necessary in order to arrive at a definite working basis.

Since ecology is such a young branch of phycology there are innumerable problems, any one of which would repay study. Some, however, are more outstanding or of greater urgency than others. So far there has been too little attention paid to the operation of critical levels. The existence of these was first discussed by Colman (Journ. Mar. Biol. Ass. U. K. **18**: 435. 1933) and since then by David (Ph.D. Thesis, Aberystwyth. 1941). There is no doubt that such levels are of prime importance but further studies are essential before we can really understand their significance. It is also probable that in different localities the critical levels will vary and this should provide a clue to the dominant factors. More or less associated with this problem is the non-tidal exposure factor. The importance of this on salt marshes has already been emphasized (V. J. Chapman, Journ. Ecol. **27**: 160. 1939) but it has not yet been studied for the rocky litoral. It is believed that the incidence of these periods, when no inundation occurs, has a profound effect upon the occurrence of many species, especially when the periods operate during the germling phase. Whether the effect is due to actual lack of water or to loss of water or to some other cause has also to be determined. These remarks particularly apply to the fucoids and here we can appreciate how important it will be when we can distinguish with certainty in the field from their very earliest stages, the germlings of the different species. Up to the present, largely because of this difficulty, insufficient attention has been paid to the germling phase. In the case of *Ascophyllum*, for example, this would seem to be all-important because it is absent from areas exposed to strong wave action: young plants are not to be found in such places so that the inhibitory effect takes place at a very early stage.

Studies of recolonization after denudation or on new surfaces, such as those by Rees (Journ. Ecol. **28**: 403. 1940), David (l. c.) and Bokenham (Ann. Nat. Mus. **9**: 1938), will lead to important conclusions and help us to understand the interrelations between different species on the shore. Such work has already shown that colonization by *Fucus* is commonly preceded by the development of an *Enteromorpha* mat. It has been suggested that this mat provides the necessary humidity for the *Fucus* germling, but it may equally well provide a suitable substrate

for attachment. In any case the function of this mat in promoting the attachment of germlings requires investigation. The part played in the different communities by microscopic and encrusting species is not properly appreciated, though in this case it is partly due to a lack of adequate systematic knowledge. Yet again studies of areas associated with peculiar environmental conditions, such as that of the Baltic by T. Levring (Ph.D. Thesis, Lund, 1940), cannot help but lead to important results. The abnormal conditions induce morphological changes or ecological variations which can often be correlated with the operation of a single factor. Such areas are not common, but it is important that they should be investigated wherever they occur.

Studies of geographical distribution may be regarded as a part of ecology and here there is almost a virgin field. Some work can be carried out with the use of existing floras, but in many areas the floras cannot be employed because of the unsatisfactory condition of their systematics and uncertainty of synonymy. Plant geographical studies of the phanerogams have led to extremely important conclusions, and there is no reason to suppose that similar studies of the algae will not do likewise.

In fossil botany the principal interest, so far as the algae are concerned, would seem to be with that new group, the Nematophytales (W. H. Lang, Phil. Trans. B. **227**: 245. 1937). It is to be hoped that further material will be discovered that will provide decisive proof as to whether they were algae or not. If an algal nature is confirmed then they will take their place as perhaps the most interesting algae of all time.

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# NOTES ON NEW ENGLAND ALGAE

## III. SOME INTERESTING ALGAE FROM MAINE[1]

Roy M. Whelden

Casual observation of collections of freshwater algae from the numerous waters of Maine reveals an algal flora of surprising richness; more careful attention shows it to be well worth intensive study to which the following notes may be considered only as an introduction.

The collections on which these notes are based have been selected from several hundreds of vials of algal material gathered in every month of the year through seventeen years. Beyond the statement that no collection noted here was made from any large body of water, either lake or river, no description can be made to include the many habitats from which collections were made. One might stress the fact that several separate collections were made from what appeared to be the least promising places, such as a shallow rain pool formed in a foot-path. Despite what seemed to be a sterile habitat, a sample nevertheless was taken and later found to contain an abundance of *Closterium macilentum*, a large percentage of which was in some stage of conjugation. This and other habitats to be mentioned subsequently seem to justify the statement that no place should be passed by too carelessly, since surprising discoveries may be completely missed by such lack of attention.

As originally planned, collections were made as frequently as feasible from as wide a variety of habitats as possible: from densely shaded brooks or pools; from cold water and some from shallow pools in full sunlight when the water at the time of collecting was extremely warm; from crystal clear waters to some of deepest brown color. Final selection of material to be considered is due in part to its rarity, to the occurrence of anomalous forms, to noteworthy variability, and to stages of reproduction.

### MYXOPHYCEAE

The presence of blue-green algae was frequently noted in a large majority of the collections; in no case did these algae occur in any quantity. One of the most interesting of these was *Eucapsis alpina* Clements and Shantz (Fig. 1) which was found in abundance in a single station, a vegetation-filled pool in which the water was only a few inches deep, with several feet of slimy brown ooze beneath. The *Eucapsis* colonies varied in size from small ones having only sixteen cells to large compound groups of more than five hundred cells. The first specimens observed were collected in early June; later they were found in abundance up to mid-November. Many colonies were examined and the component cells carefully measured. When mature the cells were of strikingly uniform diameter. Different colonies showed a rather wide range of

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 221.

cell size: many were formed of cells 2–3 $\mu$ in diameter — var. *minor* Skuja; others, found with the small ones, were 3–4 $\mu$ in diameter. Very many more had cells 6–6.5 $\mu$ in diameter; often the large-celled colonies were composed of the largest number of cells. The presence of this alga was observed at this station from 1927 to 1940. Not once, despite repeated search, was it found in any other of the extremely numerous habitats, some very like this one and only a few rods away. Frogs and a variety of wading and swimming birds are frequent here; yet it would seem that they have never successfully transported this alga elsewhere.

Occurring in the same marsh with *Eucapsis*, and in many other places throughout the southern half of the state is *Glaucocystis nostochinearum* Itzigs. This alga seems always to occur sparingly.

In one shallow marsh, specimens of *Anabaena* were found in small numbers, always occurring singly and devoid of any obvious sheath. The spherical cells comprising each filament were 1.5 $\mu$ in diameter or slightly less; the heterocysts were also spherical and 2–2.5 $\mu$ in diameter; akinetes were always remote from the heterocysts and were cylindrical, 4.5 $\mu$ in diameter and 18.5–22 $\mu$ long. While somewhat smaller in all dimensions, this seems to be *Anabaena minutissima* Lemm. The only specimens found were from this single station. *Anabaena flos-aquae* (Lyngb.) Bréb. is found rather frequently throughout this region. Its var. *minor* W. West was found in one place in large amounts. The numerous filaments were of cells 2.7 x 2.0 $\mu$ in diameter. The heterocysts were 2.8–4 $\mu$ diameter, and the akinetes, present in large numbers, varied from 5.9 x 12 $\mu$ to 8.4 x 22 $\mu$.

The many other species of blue-green algae found in this region may never have been reported as occurring there. However they are of such common occurrence there and elsewhere that their presence may be expected. For the present at least they remain unnoted.

## CHLOROPHYCEAE

Among the green algae one finds many of particular interest. One of these was a species of *Closteridium* (Fig. 7) which occurred rather abundantly in a small marsh pool. The majority of the solitary cells were semi-circular in shape with one side straight or only slightly curved. Each pole bears a single pointed spine which may be straight but frequently is distinctly curved. The cell wall is thin. The single chloroplastid fills nearly the entire cell and contains a single pyrenoid and also a single nucleus, the latter approximately centrally located in the cell. These cells vary considerably in size, being usually between 75 and 95 $\mu$ long (including spines) and 30–40 $\mu$ in maximum diameter. The spines are 11–13 $\mu$ long. The smallest cell measured was only 63 $\mu$ long and 23.5 $\mu$ in diameter. Among the many cells seen were a large number apparently in various stages of division. The most noticeable feature of these was the presence of two distinct pyrenoids, which probably re-

sulted from the division of the single pyrenoid normally present. Once divided the two pyrenoids seem to move apart subsequent to which there appears a distinct division of the chloroplastid, leaving a single cell with two distinct plastids. Several of these were seen. Further stages showing that actual cell division did occur were not found. Cells in which these stages occurred were 100–105 μ long but with diameters of the same magnitude as had the normal cell. Despite the rather larger dimensions and coarser habit this alga seems to agree quite well with descriptions of *C. siamensis* (W. and G. S. West) Wille, reported in this country by Prescott.

Occurring with the *Eucapsis* considered above and apparently also restricted to the one pool, is a species of *Tetraëdron* which has appeared regularly in collections made throughout many years. The thick-walled cells are triangular with sides generally strongly convex, or occasionally straight or slightly concave. Each angle bears a single stout, curved, straight or rarely slightly hooked spine. The single chloroplastid contains no pyrenoid. The length of the cells, spines included, varied from 102–118 μ, without spines from 77–84 μ; the breadth, without spines, from 50–62 μ. The length of the spines is 11.3–17 μ.

W. and G. S. West in 1895 described, without any figure, as *Tetraëdron tortum*, a species which has much in common with that considered here. Their species was relatively narrower, 44 μ being given as maximum breadth, twisted, and with sharp spines about 30 μ long. The specimens herein described are much plumper, in end view generally presenting sub-circular outline; they rarely, if ever, show a shape that could be described as twisted, and they have much shorter spines. This combination of characters seems sufficient to justify describing this as a new species,

**Tetraëdron mainensis** n. sp. (Fig. 4).

*Tetraëdron* cellulis magnis, tumidis, trigonis, lateribus convexis, vel rectis vel rarissime plus minus concavis; anguli spinas crassas rectas, vel arcuatas vel plus minusque uncinatas ferunt; membrana crassa glabra; cellulae cum spinis 102–118 μ longitudine et sine spinis 77–84 μ longitudine, 50–62 μ latitudine, 40–51 μ crassitudine; spinae 11.3–17 μ longitudine.

The desmids have always received much attention, partly because of the striking variety of their many species and their beautifully symmetrical shapes. No less interesting are the many problems they offer — problems of distribution, of habitat, of variability, of reproduction have frequently drawn attention. In the region considered in this paper, desmids are one of the most abundantly encountered groups of algae, and certainly are not devoid of interest.

One of the commonest species, occurring throughout the region, is the ubiquitous *Netrium digitus* (Ehrenb.) Itzigs. and Rothe. Attention was drawn to the numerous observed specimens by the wide range in size: the smallest specimens were 80–85 μ long and about 30 μ broad, and a well graduated series existed which varied from these smallest specimens

up to those that are 300 $\mu$ and more long and 90–100 $\mu$ broad. The cell outlines varied from sub-cylindrical to fusiform, with broadly rounded to truncate ends.

*Closterium* occurs in abundance throughout the region. Collections may frequently be made in which a single species occurs, but more frequently specimens of this genus are found scattered among other algae. Zygospores are not infrequently found, developing at all seasons of the year. One pool gave *Cl. rostratum* Ehrenb. zygospores in April; in July, zygospores of *Cl. Ralfsii* var. *hybridum* Rabenh. were found; and in September *Cl. setaceum* Ehrenb. was conjugating freely. Usually only a small part of the specimens are conjugating, but occasionally one finds instances in which large numbers are seemingly forced to conjugate at the same time. The *Closterium macilentum* Bréb. mentioned earlier offers such a case. In this collection many of the zygospores departed considerably from the spherical shape described by Brébisson for this species, and were much larger. The example in Fig. 3 is 53 x 57 $\mu$ and rather vaguely angular in shape. The cells contributing to this were 420 x 17 $\mu$ and 460 x 15 $\mu$. The zygospores of *Cl. Ralfsii* var. *hybridum* Rabenh. were spherical and 70–80 $\mu$ in diameter.

Many interesting problems other than zygospore formation present themselves here. Sigmoid forms occur very frequently; examination shows that in some cases the cells which appear as sigmoid are really of spiral form. In like manner the striae or ribs so characteristic of many species may depart from the normal arrangement in which they are parallel to the optical margin and run in spirals around the cell. More frequently the spiralling is restricted to the apical portion of each semi-cell. Another feature in the cells of this genus is the gypsum particles found in the terminal vacuoles. Variation of these granules is often great, as in a collection of *Closterium angustatum* Kütz., in which some cells had vacuoles containing as many as sixteen long slender granules, others 6 to 10 ovoid particles, others two to six broadly cylindrical granules, and many but a single large nearly spherical one. The granules in the two ends of a single cell might be quite different. Cells from this same collection showed many with spiral ribs. Some are shown in Fig. 5. Many other species have a similar range of variation in granules. Abnormally shaped cells are not infrequently found in collections of this genus. Already mentioned are the sigmoid and spiral forms. Occasionally more abnormal forms appear. The two examples of *Closterium striolatum* Ehrenb. shown in Fig. 8 are from a collection in which many such cells occurred. In some the apical portion was almost at a right angle to the cell axis; all degrees of bent cells were found between these and quite normal cells. No cell was found in which both ends were abnormal. In a few cases cells were found in the later stages of division, with the younger semi-cells of the two daughter cells showing the same type of bending.

Specimens of *Spinoclosterium curvatum* Bernard (Fig. 6) have appeared in several widely separated parts of Maine. The cells vary somewhat, especially in the degree of curvature and the shape and orientation of the apical spines. The latter are usually straight and from 17–21 $\mu$ long, but occasionally curved spines are found. Many specimens showed terminal vacuoles containing 8–10 small granules. Cells were frequently found containing specimens of a parasitic fungus (*Olpidium* sp. ?) so frequently found in *Closterium* and other desmids.

Occasionally one finds a collection of desmids which is practically pure, containing but a single species, in the most unexpected places. One such was gathered from a shallow sand pit into which a small turf of *Polytrichum* moss had slid. No algae were apparent in the clear water some ten inches deep, yet examination showed the mosses covered with masses of *Euastrum oblongum* (Grev.) Ralfs. Most of the cells were very uniform in appearance, 155–175 $\mu$ long and 82–90 $\mu$ broad. One specimen merits notice, and is shown in Fig. 2 (right). First observation indicated that a zygospore was present: examination showed it to be a cell in which division had gone to the formation of a large somewhat spherical mass 108 $\mu$ in diameter with a coarsely irregular surface and dense contents of which the nature could not be determined. The specimen shown in Fig. 2 (left) presents certain troublesome points: it is 161 $\mu$ long and 80 $\mu$ broad; in one semi-cell the upper lateral lobes are rounded, suggesting *E. humerosum* Ralfs: in the other the corresponding lobes are subquadrate with retuse margins and are characteristic of *E. oblongum*.

Anomalous cells result from arrested divisions in other desmids as well as *Euastrum*. Fig. 10 shows two such cells of *Cosmarium bioculatum* Bréb., together with a normal cell. In both abnormal cells shown and in several other similar ones seen, specimens of a parasitic fungus occurred.

*Cosmarium subturgidum* (Turn.) Schmidle is a rare species described from India. A smaller forma *minor* has been found in Asia, Africa and Australia. It is interesting to note that a form should appear in Maine, where it occurred in considerable numbers in a small pool in a *Sphagnum* bog near the coast. The cells were large, from 2.6–3.7 times as long as broad, distinctly constricted, sinus obtuse, angled; semi-cells ovate with truncately rounded ends; cell-wall smooth except in apical portion where many coarse irregularly distributed pores appear. Vertical view circular. The chloroplastids are parietal longitudinal bands, 7–8 per semi-cell, and of these 3–4 are visible in face view. The cells are 130–145 $\mu$ long, and 46–48 $\mu$ in maximum diameter. The isthmus is 38–44 $\mu$ broad. These cells are distinct from the species and form by their narrower shape and by the presence of pores at the apex, and so are described as a new form of this apparently rare species. (Fig. 9.)

Species of *Micrasterias* are among the commonest of the desmids of

this region, twenty-four species having been found, mostly in abundance and widely distributed. All species show considerable variation in the nature of the lateral lobing. Anomalous forms seem however to be relatively rare. Two such cells of *Micrasterias rotata* (Grev.) Ralfs are shown in Fig. 15. These occurred in a shallow slow-flowing brook of clear cold water in which there were thousands of cells of this species. The few anomalous forms were all of the same nature, represented by individuals in which one semi-cell had the lobes much distorted and sometimes nearly at right angles to the main axis of the cell. No evidence of any disturbing factor could be discovered. Another collection of *Micrasterias* proved to be of more than passing interest. It was made from a small pool in a brook flowing very slowly through a swamp. Few indeed were the cells found on examination of the material—a few specimens of *Closterium*, one or two specimens of *Staurastrum muticum* Bréb., and a somewhat larger number of *Micrasterias* specimens. All the latter were of a single species, but no two were found to be exactly alike, nor did any cell have its two semi-cells alike. In several cases one semi-cell was quite definitely *Micrasterias pinnatifida* (Kütz.) Ralfs; in others a semi-cell suggested *M. oscitans* Ralfs. By far the greater number of the semi-cells were not easily assigned to any species. Variations were particularly noticeable in the lateral lobes, which appeared now broad, now narrow, nearly entire or provided with prominent apical spines. The variations of the polar lobe were less frequent and often less pronounced, and included an apical margin which varied from straight to strongly convex, and with ends merely angular, or with one tooth or two. Separating the lateral and apical lobes the incision varied from extremely narrow to very broad. In many cases the two sides of a semi-cell varied somewhat, though usually they were of the same general pattern. No noticeable variations could be observed in the other species of desmids present. Four specimens of this *Micrasterias pinnatifida* (Kütz.) Ralfs are shown in Fig. 16. The cells are 58–69 $\mu$ long, 63–71 $\mu$ broad, and the isthmus is 8–12 $\mu$ broad.

Four species of *Xanthidium* are here found widely scattered and in abundance. These are *X. armatum* (Bréb.) Rabenh., *X. antilopaeum* (Bréb.) Kütz., *X. cristatum* (Bréb.) Kütz., and *X. tetracentrotum* Wolle. Other species such as *X. subhastiferum* W. West and *X. pseudobengalicum* Grönb. also occur, but infrequently. The commoner species hold particular interest because of the extreme variability which seems to be exhibited. The specimens of *X. tetracentrotum* shown in Fig. 14 serve to illustrate this very well. All these are from a gathering in early August from a small pond. At the time of collecting, the plants were actively dividing, filaments of 4–8 cells being found in abundance. All cells were of normal size for the species, being 38–45 $\mu$ long, 35–45 $\mu$ broad without spines, and 52–65 $\mu$ with them, and 24–26 $\mu$ thick. The isthmus was 10–12.5 $\mu$ broad. The cells bore a yellowish brown thickened area

in the middle of the lateral face; the scrobiculations thereon sometimes formed a semicircle or crescent, but more frequently a complete circle. Within the circle a few accessory scrobiculations often appeared. Greatest irregularity attached to the spines, both in their number and their disposition. The smallest number found was in those cells in which each lateral angle bore a single spine. Other cells bore a pair of spines in each angle, or eight spines for the entire cell. All variations between these were found, the paired spines being in a horizontal plane. One of these is shown in vertical view in Fig. 14, the semi-cell having two spines on one angle and one on the other. The other semi-cell has unpaired spines. In many specimens there were two spines to each angle, but they were in a vertical plane. Often unpaired spines were found above these, the cell shape then becoming subhexagonal instead of elliptical. Many cases were observed in which a prominent papilla appeared instead of a spine. Some specimens presented a decidedly asymmetrical appearance as a result of the very irregular disposition of the spines. All the variations or irregularities noted were cells which could be considered mature, the central ornament being deeply colored or the cell actively dividing.

*Xanthidium antilopaeum* (Bréb.) Kütz. is much more widely distributed in this region than is *X. tetracentrotum* Wolle, several distinct varieties being found. One of these is Irénée's var. *quebecense*. Many specimens of the latter are much larger than his, the largest measured being 100 $\mu$ long (with spines), 92 $\mu$ (without spines), 106 $\mu$ wide (with spines), 90 $\mu$ (without spines), and the isthmus 16–23 $\mu$ broad. The central scrobiculations varied greatly in different specimens, but most frequently these were arranged in a broad ellipse within which many others formed a second ellipse or were most irregularly disposed. Several zygospores were found in the same collection, but none with empty semi-cells attached. They were spherical and about 60 $\mu$ in diameter, without spines. The surface bore many simple straight spines 11–15 $\mu$ long. It seems quite possible that these are zygospores of the numerous var. *quebecense* cells present.

A pool of stagnant water in a large granitic ledge contained large numbers of another form of *Xanthidium antilopaeum*. The many cells examined are of very uniform appearance and represent a distinct variety. They are of medium size, about one and one-quarter times longer than broad, sinus at first linear, then divergent to a rounded basal angle. Apex usually straight, less frequently slightly convex, infrequently faintly retuse, the lateral margins straight or slightly convex. Angles rounded, each furnished with a pair of stout upwardly curved (rarely straight) spines frequently yellowish-colored. In a few instances a third spine may exist between or lateral to one or both pairs of basal spines. Central thickened area brownish-yellow and circular or elliptical, and furnished with numerous scrobiculations which are variously

arranged. Sometimes these are very faintly visible or even completely lacking. Vertical view elliptical with truncated ends, each bearing a pair of parallel or slightly converging spines. Side view of semi-cell subcircular. Length 74–80 $\mu$; breadth (with spines) 87–95 $\mu$, (without spines) 60–68 $\mu$; thickness 45–48 $\mu$, breadth of isthmus 24–36 $\mu$; length of spines 13–16 $\mu$. Distinct from other species and other varieties in relative dimensions, in its straight apical margin, and the disposition of the spines. This plant seems to have been first described in 1888 by W. H. Hastings, presumably in his local newspaper, as *Xanthidium antilopaeum* var. *truncatum*. Soon after W. West described the same plant as *X. Tylerianum*, collected from Maine. About two years later Hastings raised his variety to species rank, citing at the same time West's *X. Tylerianum* (misquoted as *X. Taylorianum*) as synonymous. It would seem better to keep this desmid as a variety of *X. antilopaeum;* therefore it becomes **Xanthidium antilopaeum** var. **Tylerianum** (W. West) Whelden comb. nov. (Fig. 17).

*Arthrodesmus quadridens* Wood is one which has frequently appeared in collections from Maine and has always attracted considerable attention, primarily because it seemed so different from all other species of the genus. Recently Prescott and Scott, with good reasons, have removed this alga from that genus, and established for it a new genus, *Spinocosmarium*. They note that the species *S. quadridens* shows "a great variation in the degree to which granules and processes are developed". This is indeed so. However, collections vary greatly in this respect. Frequently one may examine scores of specimens in a single collection and find no obvious variation. In another collection from a habitat closely resembling the first, every specimen seems distinct in some way. The most conspicuous variation occurs in the spines which are so striking a feature of the lateral margin. These may be simple or once-furcate; between cells in which all spines are simple and those in which all are furcate, every conceivable combination of simple and furcate spines occurs. In the furcate spines the two forks are usually nearly equal in size, but instances do occur in which one fork may be reduced sometimes to a degree where it becomes merely a minute tooth on one side of the spine. Infrequently spines are borne at the apical angles and are usually much smaller than the lateral ones. Generally the spines occur singly, although occasionally two may be produced on an angle. All specimens I have examined are alike in having a single large rectangular tubercle just above the isthmus. The many other tubercles vary greatly both in prominence and in number, especially in the lateral parts of the cells. In rare cases coarse pores occur in abundance and irregularly distributed in the wall between the tubercles. Generally this wall appears smooth. The cells were 33–42 $\mu$ long, 51–57 $\mu$ broad (with spines) and 33–40 $\mu$ without; the isthmus was 9–13 $\mu$ broad; the cells were 24–26 $\mu$ thick.

Three species of *Staurastrum* merit notice because of their zygospores.

On three different occasions zygospores of *St. punctulatum* Bréb. have been found in abundance, once in mid-May and twice in late summer. The most noticeable feature of these zygospores is the broad range in size, from 36 $\mu$ to 62 $\mu$ in diameter, the processes included. (Fig. 11.)

In several shallow pools *Staurastrum Rotula* Nordst. (Fig. 12) is a species encountered frequently and generally in large numbers throughout the warmer months, becoming particularly common in August and September. During the entire period the rather large cells show a certain amount of variation; the number of processes may be either eight or nine. These rays usually are quite straight, those of the two semicells being parallel. Not infrequently one finds specimens in which the processes are curved outward. The margins of the processes are in most instances coarsely crenulate, but occasional specimens are found with perfectly smooth processes. The verrucae which are so characteristic a feature of this species also vary, being usually rather large and bidentate, in other cases small and conical, and occasionally completely lacking. Some of the specimens have larger dimensions than those usually given, being 42–48 $\mu$ long, and up to 124 $\mu$ broad (processes included).

Zygospores of this alga were found in very large numbers during August and early September of 1929. They were spherical bodies 36–43 $\mu$ in diameter, with many straight or slightly curved processes 28–32 $\mu$ long. In some zygospores the apices of all processes were armed with two or rarely three curved teeth; in other zygospores the ends of all processes were simple and rounded; in some, processes of each type occurred. The body of the zygospore was deep brown to black in color. Fig. 12 shows three zygospores with different types of processes, and two cells, one with crenulate and the other with smooth processes. Infrequently zygospores of this species were found infected with a small undetermined fungus. In these the processes were generally much shortened (10–15 $\mu$ long), coarser than normal, or even unciform. Such infected zygospores were easily recognized as abnormal, even when the parasitic body was not distinctly visible.

*Staurastrum Johnsonii* var. *depauperatum* G. M. Smith (Fig. 13) occurs quite generally in this region, sometimes in abundance, together with the species. Occasional specimens of zygospores of the present species were found. They were spherical bodies of brownish color, 28–32 $\mu$ in diameter and provided with 12–15 simple straight processes 16–20 $\mu$ long.

Disregarding purely taxonomic problems and those dealing with the life-histories of algae, interest in this group of plants has centered around three main questions, their distribution in both a local and a broader sense, the variations that they exhibit and possible explanations of them, and the formation of sexual stages, with some attention being given to the periodicity of their existence.

The appearance of sexual stages and especially of zygospores in the

desmids, is often a rare occasion. To record their occurrence, therefore, seems ever desirable, the more so when notes on any unusual circumstances attend this; with the accumulation of such cases an understanding of some of the causes leading thereto may be had. Certainly my own observations on zygospores, far more numerous than those recorded above, lend no support to any statement that any one season favors their appearance. Frequently one finds a collection in which many different species of the algae present are fruiting freely, thus suggesting that this event is a consequence of external factors. The collection in which the zygospores of *Staurastrum Rotula* were so abundant is of this sort, for in this ten different algae, including eight desmids, were forming zygospores. In other cases, large numbers of algae may be present, and only one fruiting. Collections in which a dozen species of *Closterium* are abundant may show only one forming zygospores. It might then be suggested that an internal factor might be operating.

The question of occurrence, or favorable habitats, may be briefly mentioned. Everyone who has given serious attention to collecting algae knows that there are problems involved, in deciding just where collecting may be best. Nor can any rule be given for this. A collection may be very poor in numbers and quantity, yet show rich variations in the material that is present. Apparently identical habitats may show entirely different results, one spot yielding abundant material while one nearby is almost barren. Variations of this kind may be found in two collections made in a monotonously uniform habitat and only a foot apart. It would seem that oftentimes the algae maintain a remarkably fine adjustment to some factor or factors in their environment or within themselves. All too frequently algae, especially desmids, may disappear from some place with startling abruptness, not a trace remaining in a habitat which twenty-four hours before gave very rich collections.

The question of variations in algae and the causes of them has attracted considerable attention. Jacobsen (1875) was one of the first to consider the nature and causes of variations so frequently observed in desmids. He advanced several possible explanations and noted the wide geographical range of the variations. De Wildeman (1887) paid attention to this question, brought together may cases of variations noted by previous workers and concluded that . . . "ce ne sera que par une étude approfondie faite sur de nombreux matériaux de diverses provenances que l'on pourra arriver à donner, à chaque espèce, la place qui lui convient dans la série et à supprimer toutes les espèces dont la creation est basée sur der caractères secondaires." Later de Wildeman (1895) noted the frequency of occurrence of variations in the genera *Euastrum* and *Micrasterias*. Cushman (1907) found the species of *Micrasterias* to be very variable, and remarked that "as many of these so called varieties are often seen forming one semicell of a specimen, the other semicell of which is typical, it seems hardly wise to recognize them as

good varieties." Johnson (1894), Stange (1908), Playfair (1910), Ducellier (1914, 1915, 1917, 1918), Woronichin (1926) and Huber-Pestalozzi (1931) are among the many who have given considerable attention to the occurrence and extent of variations under natural conditions, and offered various explanations as to their causes. More recently Lefevre (1939) has studied the problem both in nature and more especially in cultures. His extensive experiments on several genera and species of desmids lead him to conclude that anomalies and monstrosities appear much more frequently in cultures than in natural habitats. He is led to state that "Observations based on material grown in culture can never replace material observed in nature, but will serve only to supplement these and may give proof to matters otherwise left very doubtful."

The notes on variations recorded above are based on materials from natural environment. They lead to certain observations. Monstrosities such as those in *Euastrum* and *Cosmarium* do occur infrequently and in many cases at least seem to be accompanied by, if not indeed a consequence of, attack by a parasitic organism. It is quite possible that in such abnormal forms as those of *Micrasterias* (Fig. 15) a parasitic organism is present, but in a stage the presence of which is not yet apparent. For certain it is that this genus is frequently infested with parasitic organisms. Possibly such abnormal forms occur only if the parasite enters just before division of the host begins, or in its early stages.

It has frequently been stated that the many variations in size, form, ornamentation, and cell contents occur much more frequently in certain genera. Undoubtedly this is true. It is also a fact that in many cases the very nature of the cell makes it difficult to observe variations — small smooth species of *Cosmarium* cannot offer as much in the way of variety as ornate ones. Where obvious variations do occur it is seldom possible to ascribe to them definite causes. Many factors outside the cell come to mind. Abrupt changes in temperature, and large fluctuations in the amount of substances dissolved in the water have been frequently mentioned. Yet when one observes what happens in two small nearby pools, or examines two collections from points near one another in a single pool, where great variation appears in some of the species in one and as great uniformity in the species in the other collection, one concludes that such a factor cannot always operate. Nor do they seem adequate to explain all observations. Many things indicate that there is within the organisms themselves something which may lead to the appearance of variations, and that this together with other external factors operate together perhaps in very subtle ways to bring about the morphological changes which one observes. Only through observations accumulated slowly, and carefully supplemented whenever possible with observations on controlled cultures, can a solution of these problems of algal behavior be hoped for.

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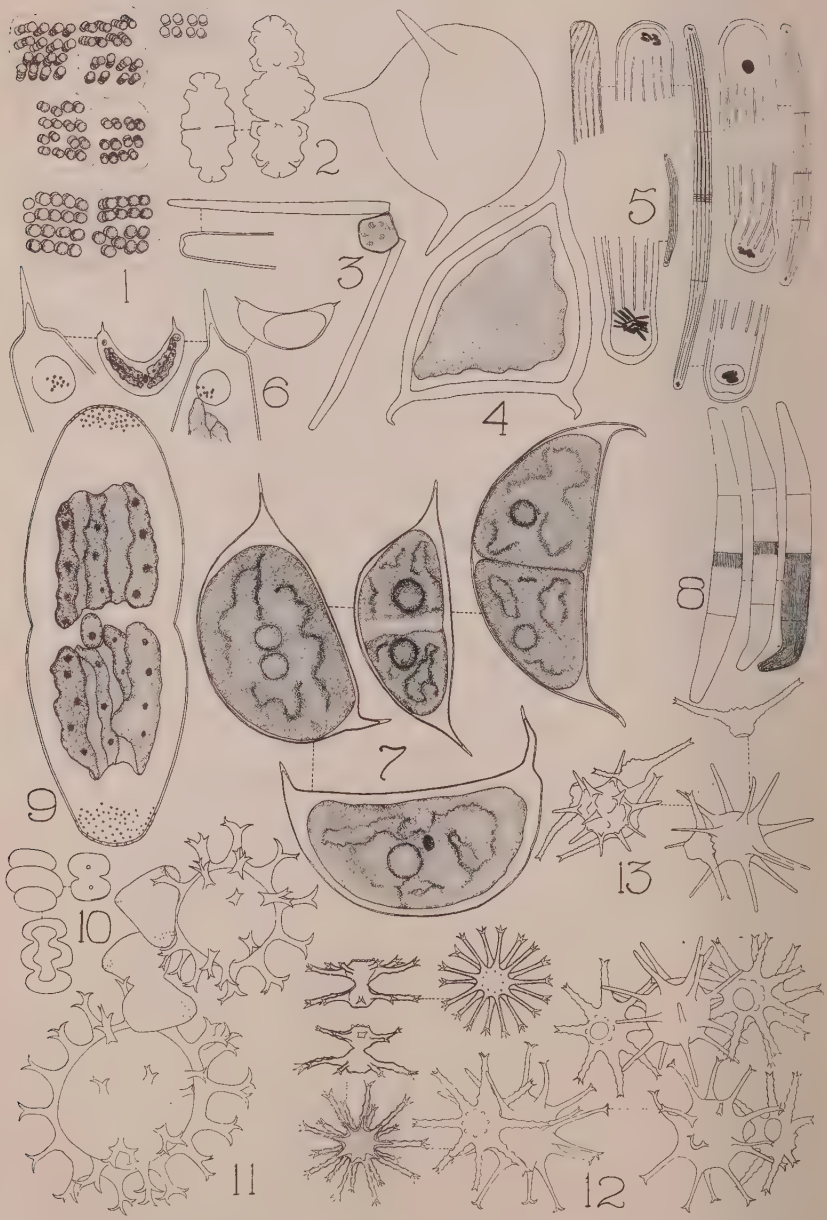
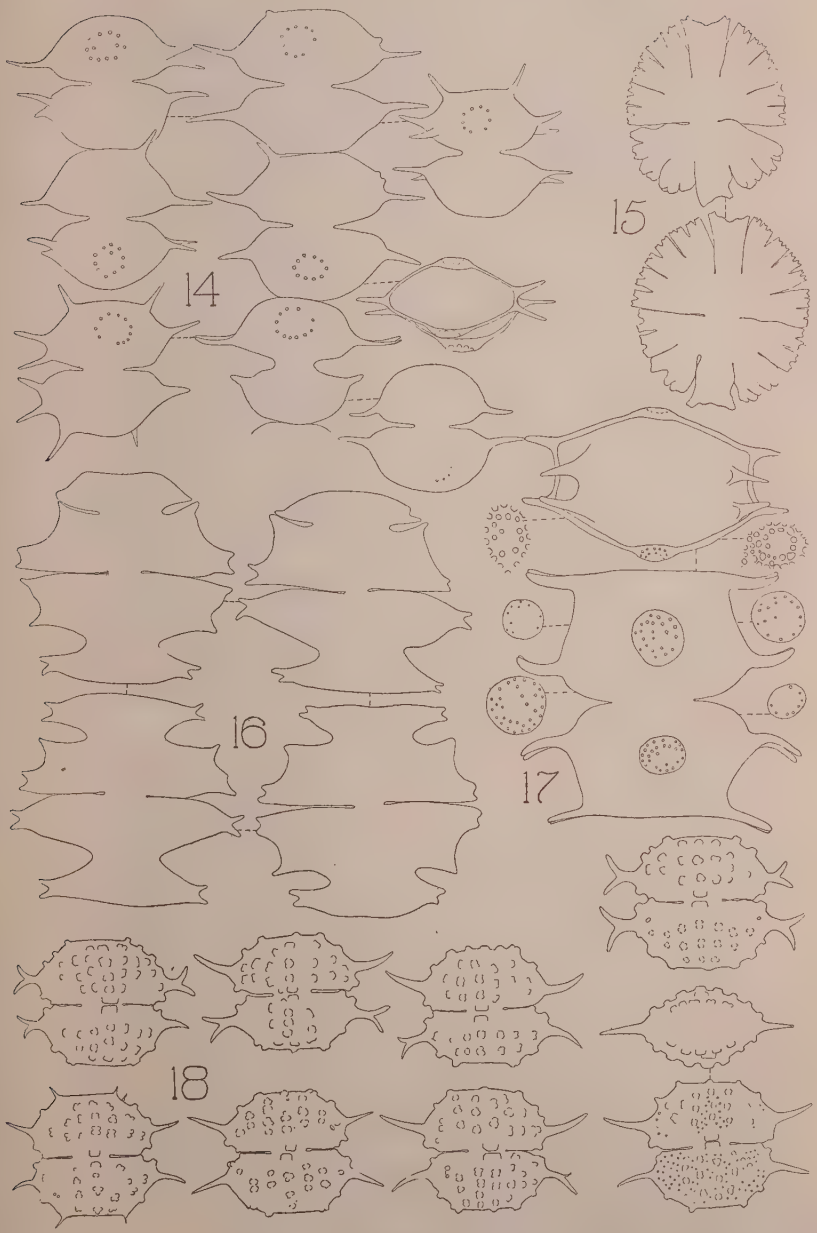
## EXPLANATION OF FIGURES

1. *Eucapsis alpina* Clements and Shantz. Several small colonies, composed of cells 2–5 μ in diameter.
2. *Euastrum oblongum* (Grev.) Ralfs.
3. *Closterium macilentum* Bréb. Zygospore.
4. *Tetraëdron mainensis* n. sp.
5. *Closterium angustatum* Kütz., showing several forms of gypsum granules, and cases in which the ribs become spiral in the apical portion of the cell.
6. *Spinoclosterium curvatum* Bernard, the right-hand figure showing a parasite fungus.
7. *Closteridium siamensis* (W. and G. S. West) Wille.
8. *Closterium striolatum* Ehrenb. One normal cell and two with one end abnormally bent.
9. *Cosmarium subturgidum* (Turn.) Schmidle, forma.
10. *Cosmarium bioculatum* Bréb. Two anomalous cells with parasites, and one normal cell.
11. *Staurastrum punctulatum* Bréb., showing conspicuous variation in size of zygospores.
12. *Staurastrum Rotula* Nordst. Two cells, one with crenulate, the other with smooth processes; three zygospores.
13. *Staurastrum Johnsonii* W. and G. S. West var. *depauperatum* G. M. Smith. Zygospores.
14. *Xanthidium tetracentrotum* Wolle, showing variations in number and disposition of spines, and in the ornamentation.
15. *Micrasterias rotata* (Grev.) Ralfs. Two cells each with an anomalous semi-cell.
16. *Micrasterias pinnatifida* (Kütz.) Ralfs, showing extreme variations in one or both semi-cells.
17. *Xanthidium antilopaeum* var. *Tylerianum* (W. West) Whelden comb. nov. with scrobiculations from several different cells to show degree of variation therein.
18. *Spinocosmarium quadridens* (Wood) Prescott, showing variations in lateral teeth and in surface ornamentation.




FIGURES 1–13




FIGURES 14–18

1(1): 25–40 FARLOWIA January, 1943

# ALPINE MOSSES FROM NEW GUINEA

H. N. Dixon

The mosses collected by the Netherlands Colijn Expedition to New Guinea, 1936, were submitted to me by the Botanical Gardens, Buitenzorg, for determination. They were collected by F. J. Wissel, on Mt. Carstensz, from altitudes above 4000 m. Though the collection was not large, it was of extraordinary interest. In fact, out of about twenty species collected, at least fifteen were new to science, three were indeterminate species, but fragmentary, all probably undescribed, and the remaining two have probably been collected only in their original habitat.

For these I have given Wissel's collecting numbers, and have added the reference numbers under which they were sent from the Herbarium at Buitenzorg (abbreviated as BZ).

Mosses collected by the late C. E. Carr, in Papua, mostly at altitudes above 2000 m., above Port Moresby, have from time to time been sent me by Dr. Verdoorn. These also contained a considerable number of species new to science, as well as some known, but hitherto not recorded from New Guinea. These also I have included, as well as a small number sent by other collectors: the last not so distinctly alpine.

The contents of these collections reveal what a great addition to bryological knowledge remains to be made by intensive collection in New Guinea, especially at high altitudes. The relationship between this flora and that of Borneo, Celebes, Sumatra, etc., becomes still clearer, the interest perhaps being all the greater from the occurrence of alpine species already known from, or closely related to species from those regions.

## SPHAGNACEAE

**Sphagnum sericeum** C. Müller

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 15190*, c. fr. The fruit, I believe, has not been recorded. The pseudopodia are long, over 5 mm., from long fruiting branches with very large, broad perichaetial leaves.

## FISSIDENTACEAE

**Fissidens subspathulatus** Dix. sp. nov.

Semilimbidium. Caulis simplex vel sparse ramosus, circa 3 mm. altus; folia circa 5-juga, inferiora minima, subsquamosa, superiora multo longiora, patentia, percomplanata, sicca valde crispata, late oblonga vel leniter spathulata, rotundato-obtusa, raro minute apiculata, ubique crenulata; lamina dorsalis infra angustata, apud basem folii oriunda; lamina vaginalis circa dimidiam partem folii aequans, anguste, sed distincte limbata, limbidio potius viridi quam hyalino. Costa sat debilis, concolor, sub vel cum apice desinens. Cellulae propter chlorophyllam et tenuitatem parietum subobscurae, unipapillosae, parvae, irregulares, versus basem laxiores.

Dioicum. Flos ♂ terminalis in cauli breviore, turgidus. Seta geniculata, tenuis, 3–4 mm. longa. Theca erecta, angusta, in setam defluens; operculum rubellum, longe

recte rostellatum. Kanosia, Papua, terrestris ad basem arborum, 22 Feb. 1935; coll. *C. E. Carr, 11469*, **type.**

Distinct in the subspathulate, obtusely rounded leaves, much crisped when dry, the cells rather obscure, but not opaque. The margin is sharply crenulate, at apex even subdenticulate. *F. rupicola* Broth. & Par. is a much more rigid plant, with leaves narrowed above, as in *F. geniculatus* Thér., where the cells also are very opaque and the nerve pellucid.

**Fissidens kurandae** Broth. & Watts.

Prope Port Moresby, Papua, 1935, coll. *C. E. Carr, 12507*. c. fr. New to New Guinea. DISTR.: Queensland.

The fruit has not been described. Seta 2–3 mm. Capsule erect, small, narrowly elliptic.

## DITRICHACEAE

**Ditrichum Colijnii** Dix. sp. nov.

Elatum, robustum, atro-fuscum. *D. spinuloso* Dix. borneensi affine et simile; differt foliis *magis sensim* e basi attenuata, subula tenuiore, haud compressa, *confertius, tenuius* denticulata, costa *perlata* et *pessime definita*, cellulis basilaribus elongatis, linearibus, parietibus *valde incrassatis et fortiter sinuosis*. Zuidwand, Geele Dal, Mt. Carstensz; coll. *Wissel, 65* (BZ, 3999), **type.** Meerendal, Mt. Carstensz, 4000–4100 m.; *Wissel 29* p. p. (BZ, 4006b).

A fine species, allied to *D. spirale* Dix. from S. Africa, and *D. spinulosum* Dix. from Mt. Kinabalu. The latter differs in the broad, flattened subula, very coarsely and distantly toothed for some way down; here the excurrent nerve is finely subulate, terete, sharply but finely toothed only near the apex. It shares with these the glossy, spirally twisted subula when dry. The nerve is very broad, occupying often three-fourths the width of the base, but very ill defined; in section showing 2–3 rows of subhomogeneous, much thickened cells.

## DICRANACEAE

**Microdus papuanus** Dix. sp. nov.

*M. brasiliensi* (Duby) habitu et foliis simillimus, fructu autem sat distinctus. Theca *multo angustior*, e collo distincto *anguste elliptica* vel subcylindrica, deoperculata circa 1.5 mm. longa, vix .5 mm. lata, vetustate sub ore contracta. Peristomium *minus*, dentibus et videtur brevioribus, integris. Port Moresby, Papua, 1935; coll. *C. E. Carr 12,506*, **type.** Koitaki, Papua, in road cutting, circa 450 m., soc. cum *Garckea phascoides*, May, 1935; coll. *C. E. Carr 12,243.*

No. 12,243 was distributed as *M. brasiliensis* (Duby) Fleisch., on my determination, by Verdoorn (Musci Selecti et Critici, No. 189); it agrees with that species vegetatively altogether; the fruit was very sparse and in poor condition. The later gathering, however, showed the fruit in good condition, and it was at once obvious that it could not be referred to Duby's plant, *M. pomiformis* (Grif.) Besch., where the capsules are turgidly ovate or subglobose. Here they are constantly markedly elliptic

or fusiform, the collum is very distinct, and the peristome seems to be less developed. Fleischer describes the teeth as "nicht langsgestreifte," but he figures them as indistinctly striolate, which is the case also here.

**Dicranoweisia papuana** Dix. sp. nov.

Gracilis; caules dense conferti, *per tomentosi*, inter muscos alios intermixti. Folia dense conferta, sicca crispata, e basi *parum latiore* lingulato-lanceolata, 2.5–3 mm. longa, flexuosa, pellucida, sensim angustata, apice *saepe raptim cuspidato*, marginibus *planis*, costa pro latitudine folii sat valida, superne angustata, *pellucida*, percurrens. Cellulae quadratae vel rotundae, *valde incrassatae, perdistinctae*, laeves, basilares anguste lineares, parietibus incrassatis, porosis. Folia perichaetialia majora, e basi lata convoluta erecta in subulam patulam lanceolatam attenuata. Seta *brevis*, vix 5 mm.; theca erecta, parva, oblonga, pallide fusca; exothecii cellulae *laxae*, subisodiametricae, irregulares; operculo subulato-rostrato. Peristomii dentes breves, aurantiaci, sat remoti, e basi latiore lanceolati, sat remoti, irregulares, tenuiter trabeculati, papillosi. Cum *Schlotheimia emarginato-pilosa* Herz., supra Port Moresby, Papua, 1600–2000 m., coll. *C. E. Carr*, **type.**

This was mixed with the Schlotheimia in No. 237, Verdoorn, Musci Selecti et Critici, and was detected in his specimen by Mr. G. O. K. Sainsbury, and sent to me for determination. Only a few scraps occurred, which would hardly have justified publication if it had not been for the peculiar interest of the discovery, since no species of the genus is known either from New Guinea or from any near region; it is a genus of almost entirely temperate or arctic distribution of both hemispheres, or in the few occurrences in lower latitudes, of alpine stations; and the present plant must take its place side by side with the alpine *D. alpina* Dix. from Mt. Elgon and *D. fastigiata* (Tayl.) from Mt. Pichincha.

**Holomitrium novae-guineae** Dix. sp. nov.

E speciebus asiaticis *H. Griffithiano* Mitt. proximum. Differt foliis e basi *latiore* longius, angustius subulatis, apice acuminato, acuto, haud cucullato, *fragillimis;* areolatione basilari valde diversa, e cellulis medianis parietibus *valde porosis, sinuosis*, marginalibus seriebus numerosis pellucidis, parietibus tenuibus, limbum latum altum subhyalinum instruentibus. Cellulae alares haud diversae. Fructus ignotus. Meerendal, Mt. Carstensz, 4000–4100 m., coll. *Wissel, 7;* (BZ, 3990b), **type.** Ibidem, coll. *Wissel, 15, 32;* (BZ, 4003, 4008).

Small quantities and sterile only. Quite distinct from *H. Griffithianum* in the longer, narrower, more acuminate leaves from a broader base, which is slightly widened above, and the very different basal areolation. In *H. Griffithianum* the juxtacostal basal cells are narrowly linear, with firm, scarcely sinuose walls; the small, isodiametrical lamina cells descend at the margins in a broad belt, reaching nearly to the base, but becoming more elongate there, and forming a band of more opaque cells than the median. Here the juxtacostal cells have very porose and sinuose walls and are coloured, while the basal marginal form a broad band of thin-walled, *almost hyaline* cells, reaching as a pale border to near the shoulder. The extreme fragility of the leaves is also a character. The leaf apex is sometimes slightly rough.

**Braunfelsia dicranoides** (Doz. & Molk.) Broth.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 14454*, cum setis. New to New Guinea. DISTR.: Java: Philippines; Malay Peninsula; Celebes.

**Dicranoloma laevifolium** (Broth. & Geh.) Par.

Supra Port Moresby, Papua. 1600–2100 m., 1935–36: coll. *C. E. Carr. 13705.*

**Dicranoloma novo-guinense** (Broth. & Geh.) Par.

Supra Port Moresby. Papua. 1600–2100 m., 1935–36: coll. *C. E. Carr. 15229.* c. fr.

The fruit has not been described. The perichaetial leaves are closely convolute, all apparently quite muticous, seta 2–3 cm., capsule rather small, smooth, strongly arcuate, not strumose. Peristome mostly lost. but well developed.

**Campylopus** (Pseudo-campylopus) **novae-guineae** Dix. & Thér. sp. nov.

Gracilis, flavescens; caules densissime intertexti, infra rufo-tomentosi, caespites densos, altos, subsericeos, molles instruentes. *C. austro-subulato* Broth. & Geh. affinis; differt foliis comalibus longioribus, *subfalcatis*, minus strictis, *longioribus* (4–5 mm.) tenuius subulatis; costa *latiore*, circa ⅔ latitudinis folii apud basem. Dajakweide, circa 4400 m. Mt. Carstensz; coll. *Wissel, 128* p. p. (BZ, 3992a), **type.**

Certainly near *C. austro-subulatus*, and structurally similar, but Mons. Thériot has compared it with an original specimen, and finds it to differ in the above clearly defined, if not very important, characters.

**Atractylocarpus dicranoides** Dix. sp. nov.

*A. comoso* Dix. Celebensi peraffinis. Differt habitu *rigidiore*, foliis *falcatis*, *dicranoideis*, foliis perichaetialibus *longe infra apicem argute denticulatis*, seta breviore, peristomii dentibus supra *papillosis*. Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13718*, **type.** Dajakweide, circa 4400 m., Mt. Carstensz: coll. *Wissel, 126* (BZ, 3995).

Very near my *A. comosus*, but differing in its more rigid, dicranoid habit, shorter seta, often less than and rarely above 1 cm. (compared with 1 to 2 cm. in *A. comosus*), a slightly different peristome (the teeth in *A. comosus* are smooth above), and perichaetial leaves sharply toothed for some way down (in *A. comosus* they are, like the stem leaves, very finely subulate and entire or slightly toothed at the apex only).

**Brotherobryum Dekockii** Fleisch.

Meerendal, Mt. Carstensz, 4000–4100 m.; coll. *Wissel, 16*, (BZ, 4007). Only known, I believe, from the original locality, on Mt. Goliath.

## DICNEMONACEAE

**Dicnemos undulatifolius** Dix. sp. nov.

*D. rugoso* (Hook.) affinis; differt colore *pallido*, foliis *latioribus*, *profundius rugosis*, marginibus superioribus involutis, costa *validiore*, siccitate valde *carinata*, *in cuspidem*

*validum flexuosum longum* excurrente, cellulis alaribus multo magis numerosis, alas magnas, aurantiacas, ad costam attingentes instruentes. Supra Port Moresby, Papua. 1600–2000 m., 1935–36; coll. *C. E. Carr, 13787b*, **type.**

Nearly allied to the rare and peculiar *D. rugosus* (Hook.), but differing quite distinctly in the characters emphasized above, especially in the acuminate leaves with the nerve excurrent in a stout, flexuose cuspidate point.

**Eucamptodon novae-guineae** Dix. sp. nov.

Robustus, fuscus; caules plus minusve prostrati, dense ramosi, ramis erectis, usque ad 2 cm. altis, *turgidis, siccis julaceis*, 2 mm. latis, subobtusis. Folia *densissime conferta*, magna, 2.5–3 mm. longa, 1.5 mm. lata, late cordato-ovata, perconcava, ad insertionem contractam amplexicaulia decurrentia, supra marginibus fortiter involutis convoluto-acuminata, *abrupte in pilum longum capillare flexuosum subintegrum* constricta. Margines erecti, integerrimi. Costa *nulla*. Cellulae tenerrimae, *angustissimae*, elongate lineares et fusiformes, conflatae, valde incrassatae, ad insertionem pulchre aurantiacae, alares plurimae, majusculae, late hexagono-rectangulares, perincrassatae, lumine saepe minimo.

Perichaetia *praelonga*, 1.5 cm., nitida, convoluta; bractea ad apicem breviter spathulato-acuminata. Theca vix emergens, magna, e basi strumoso cylindrica, leniter curvata, laevis; operculum e basi alt conico longe, acute rostratum. Peristomium vetustum tantum unicum visum dentes lati, solidi, opaci, atro-fusci, dense humillime trabeculati, laeves, nec papillosi, ? integri. Spori 48 μ, sphaerici ? Supra Port Moresby, Papua, 1600–2100 m.. 1935–36; coll. *C. E. Carr, 15104*, **type.**

The generic position is uncertain, as the two possible genera, *Dicnemos* and *Eucamptodon*, are separated on peristome characters, and the single old peristome seen leaves it uncertain whether the teeth are entire, or possibly cleft above when perfect. The piliferous leaves suggest *Eucamptodon*, while the fructification, with the strumose capsule, closely resembles that of *Dicnemos calycinus*. The robust habit with turgid, julaceous branches, is very marked; the leaves when dry are appressed, and indeed incurved at apex, and the margins being involute above give them a claw-like appearance.

## LEUCOBRYACEAE

**Arthrocormus Schimperi** Doz. & Molk.

Koitaki, Papua; on tree trunk in forest, circa 400 m., 1 May, 1935; coll. *C. E. Carr, 12108*. New to New Guinea. DISTR.: Ceylon; Malaysia; Pacific; Queensland.

**Leucobryum stenophyllum** Besch.

Rotten logs, Koitaki, Papua. 26 Apr.. 1935; coll. *C. E. Carr, 12059*.

**Leucobryum** sp.

A plant collected by *Carr, 15229b*, supra Port Moresby, 1600–2000 m., is probably a new species, but the quantity is insufficient. It is a rigid plant, with the leaves when dry rigidly divergent, in habit, etc., very like *L. arfakianum*, but with much blunter leaves, rather widely bordered at base, and toothed apex.

CALYMPERACEAE

**Syrrhopodon bornensis** (Hampe) Jaeg.

Supra Port Moresby, Papua, 1935–36, 1600–2000 m.; coll. *C. E. Carr, 13898.* New to New Guinea. DISTR.: Borneo; Java; Malay Peninsula; Amboina.

A beautiful plant, with the vivid colouring that is characteristic of most forms of this species.

**Syrrhopodon albo-vaginatus** Schwaegr.

*S. asper* C. Müller (nec Mitt.)
*S. Beccarii* Par.

Low down on tree trunks, Kanosia, Papua, 22 Feb., 1935; coll. *C. E. Carr, 14478* (Verdoorn, Musci Selecti et Critici, Ser. IV, No. 192).

Fleischer describes *S. Beccarii* as differing from *S. albo-vaginatus* in having a flatter leaf margin, but I can find no difference in this or any other respect.

**Syrrhopodon** (Thyridium) **Wallisii** C. Müller

Koitaki, Papua, circa 400 m., on trunks of forest trees, 10 May, 1935; coll. *C. E. Carr, 12245* (Verdoorn, Musci Selecti et Critici, Ser. IV, No. 199). New to New Guinea. DISTR.: Malay Peninsula; Philippines; Great Natunas; Celebes.

POTTIACEAE

**Leptodontium erectifolium** Dix. sp. nov.

Dense, alte caespitosum, circa 5 cm. altum; caules graciles, flexuosi, *densifolii*, subsimplices. Folia *sicca appressa, madida erecto-patula*, parva, 1–1.5 mm. longa, leniter decurrentia, late oblonga, haud acuminata, plus minusve obtusa vel apiculata, sicca et madida *valde complicato-undulata*, marginibus planis vel leniter recurvatis, supra irregulariter *sat teneriter distanter denticulatis*. Costa e basi dilatata sat tenuis, *longe infra apicem* desinens, sectione duces medianos exhibens. Cellulae parvae, per papillas minutas, denas, humiles, *perobscurae*, apud basem sensim majores, subquadratae, pellucidiores, paucae ad insertionem late rectangulares, laeves, sat pellucidae. Fructus ignotus. Dajakweide, circa 4400 m., Mt. Carstensz; coll. *Wissel, 128* (BZ, 3992b).

*L. kinabaluense* Dix. has different habit, much more acute leaves and much stronger and more acute toothing, stouter nerve, etc., and *L. Warnstorfii* Fleisch, differs in the same way.

The leaves in the present plant are curiously complicated and undulate at margin, especially just below apex, where they are constricted in much the same way as occurs in many species of *Chaetomitrium;* they also recall in form some species of *Thyridium;* they are short and broad, with no differentiation of leaf base, and no acumination above.

**Barbula** (Eubarbula) **Wisselii** Dix. sp. nov.

Gracilis; *rufescens, stricta*, circa 1.5 cm. alta. Folia erecto-patentia, sicca *erecta, appressa, minime mutata, stricta*, eis *B. acutae* (Brid.) forma subsimilia, e basi ovata sensim acuminata, acuta, saepe hyalino-apiculata, concava, marginibus superne

erectis, inferne anguste explicatis; costa sat valida, dorso laevis; cellulae hexagonae, *incrassatae*, *laeves*, basilares sensim elongatae, pellucidae, breviter rectangulares, 3 x 1–4 x 1, marginales seriebus pluribus quadratae. Cetera ignota. Meerendal, 4000–4100 m., Mt. Carstensz; coll. *Wissel, 32* p. p.; (BZ, 4003c).

Fairly well marked by the colour, strict habit, leaves erect and unaltered when dry, and quite smooth nerve and cells.

## ORTHOTRICHACEAE

**Desmotheca apiculata** (Doz. & Molk.) Lindb.

On trees, circa 400 m. Koitaki, Papua, 13 May, 1935; coll. *C. E. Carr, 12273.* New to New Guinea. DISTR.: Malaya; Philippines; Borneo; Malay Peninsula; Siam; Burma.

It is exactly the Malayan plant, and therefore not *D. cymosa* (Mitt.), whatever may be the value of that species.

**Macromitrium leucoblastum** C. Müller

Rouffaer rivier, New Guinea, Aug. 1926; coll. *Docters van Leeuwen* (BZ, 2634). E descr. certainly this species.

**Macromitrium brachystele** Dix.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13309.*

Slightly differing from the original in the longer and narrower, less rigid leaves, with the cells at base mostly almost smooth. The capsules also are in better condition and show clearly the Goniostoma type; the affinity is therefore probably rather with *M. longipes* (Hook.) Schwaegr., and *M. lonchomitrium* C. M. The calyptra seems to be naked.

**Macromitrium submegalocladum** Dix. sp. nov.

*M. megaloclado* Fleisch. (Hedwigia **50**: 282) simillimum et affine. Differt cellulis inferioribus fere ad basem grosse unipapillosis, superioribus minoribus, magis isodiametricis, 10–12 μ longis, 8–10 μ latis (ibi 15–20 μ x 10–12 μ). Fructus ignotus. Nova Guinea, summit of Mt. Wichmann, 3000 m., 8 Feb. 1913; coll. *A. Pulle, 1032* p. p.; (BZ, 2124).

This may possibly be a variety only of Fleischer's species, but the difference in the cell structure is quite marked.

**Macromitrium ruberrimum** Dix. sp. nov.

*Robustum, rubrum,* ramis rigidis, 2–3 cm. longis, 4–5 mm. latis, turgidis. *M. elongato* Doz. & Molk. et *M. Braunii* C. M. affine. Folia conferta, e basi suberecta valde patentia, flexuosa; sicca valde flexuosa, vix crispata, *praelonga*, 7–8 mm. longa; e basi lanceolata sensim longe anguste ligulato-acuminata, sed apice latiusculo; margines saepe *sinuato-undulati*, ad apicem obtuse denticulati; costa angusta, carinata, sub apice dissoluta. Cellulae superiores valde irregulares et inaequales, *laeves, subrectangulares*, parietibus *perincrassatis et sinuosis*, saepe lumine latioribus; basilares omnes praelongae, laeves, conflatae, parietibus incrassatis, porosis. Fructus (in 3989) unicus visus, seta circa 1 cm.; theca vetusta elongata, 1.75 mm. longa, ad orem contracta. Meerendal, Mt. Carstensz, 4000–4100 m.; coll. *Wissel, 8, 9;* (BZ, 3988, 3989).

A fine species, distinct in the colour, robust habit, long leaves and areolation, the cells being highly incrassate, with narrow, often sinuose lumen, frequently narrower than the walls.

**Schlotheimia subrubiginosa** Dix. sp. nov.

*S. rubiginosae* C. H. Wright borneënsi affinis; differt foliis obtusis vel emarginatis, *longe cuspidatis vel aristatulis*, arista *flexuosa, superne hyalina*, marginibus apicalibus saepe leniter irregulariter erosis. Fructus ignotus. Meerendal, 4000–4100 m., Mt. Carstensz; coll. *Wissel, 7*, (BZ, 3990).

The form of the leaves in the Bornean *S. rubiginosa* varies considerably. Wright describes them as *ligulate*, but he probably intended *lingulate*, as they are certainly never ligulate (the proportions are about 3 x 1 to 4 x 1, rarely 5 x 1), and in another plant I have from Kinabalu they are even broader: oval-oblong would perhaps describe them; here they are mostly oblong, very rounded or emarginate, and with the nerve excurrent in a long cusp or arista, gradually longer higher up the stem. In *S. rubiginosa* the nerve is very shortly excurrent in an apiculus only.

**Schlotheimia longiseta** Dix. sp. nov.

*S. Campbellianae* Besch. et *S. Macgregorii* Broth. & Geh. affinis. Ab hoc differt calyptra *laevi*, ab ambabus foliis *fortiter, regulariter, pulcherrime squarrosis*, et *seta longiore*, 1.5 cm. Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13787*, **type**; *13532; 14621*.

A magnificent species, with large, beautifully regular, strongly squarrose leaves, which when dry are sometimes but not always arranged in spiral rows. The seta in *S. Campbelliana* is under 1 cm., and in *S. Macgregorii* only about 5 mm.

**Schlotheimia emarginato-pilosa** Herz.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 14515, 14534*, c. fr.

The fruit has not been described. Hitherto only known sterile, from Ceram. Seta circa 3 mm., perichaetial leaves longer than the stem leaves but otherwise similar. Calyptra smooth. Capsule ribbed. Peristome teeth opaque, solid, with a thin, pellucid median line; red, curled when dry, processes pale, erect when dry. Spores very large, variable, more or less cubic in outline, up to 40 $\mu$, opaque, very finely granulated.

## BRYACEAE

**Webera rubripila** Dix. sp. nov.

Tota planta pulchre rubra; caules circa 2 cm. alti, sicci stricti, plerumque simplices, infra radiculosi. Folia laxiuscula, erecto-patentia, sicca anguste constricta, anguste ovato-oblonga, perbreviter acuminata, integerrima; costa intense rubra, apud basem parum latior, in aristam rubram integram vel subintegram strictam, circa 3 mm. longam excurrans. Cellulae ad infimam basem paucae late rectangulares, supra rhomboideae (circa 60 $\mu$ x 10 $\mu$), parietibus firmis, rubris; margines versus seriebus pluribus angustissimae, limbum rubrum latum perdistinctum instruentes. Cetera

ignota. Dutch New Guinea; on *Ischnea*, M. Oranje, prope Meerbivah, alt. 3600 m., Feb. 1913, collected for A. Pulle (Tertia Exped. Neerlandica in Nov. Guin. Meridionalem).

A strikingly pretty plant in the colour, its affinity doubtful in the absence of fruit, but very distinct in the leaf form and the long, excurrent, red nerve.

**Brachymenium nepalense** Hook.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13309* p. p. New to New Guinea. DISTR.: India; Malaysia.

**Bryum** (Trichophora) **crispo-capillare** Dix. sp. nov.

Pusillum; dense caespitosum, fuscum, vix ultra 1 cm. altum. Folia *sicca et madida valde crispata*, haud spiraliter contorta, madida difficillime emollita, parva, 1.5–2 mm. longa, *decurrentia*, ovata, breviter acuminata, acutissime hyalino-cuspidata vel subpiliformia; costa sub apice soluta; margines plerumque plani, distincte limbati; cellulae *laxae*, hexagonae, pellucidae, inanes. Cetera ignota. Meerendal, 4000–4100 m., Mt. Carstensz; coll. *Wissel, 30;* (BZ, 4005).

A peculiar little species, with the leaves much crisped when dry, and also when moist; in fact I have found it practically impossible to regain their normal form.

**Bryum** (Rosulata) **sclerodictyon** Dix. sp. nov.

Robustum, fuscum, 5 cm. vel ultra altum, rigidum, caulibus dense intertextis, *turgidis, siccis subjulaceis*, apice subcuspidatis. Folia confertissima, patula, 2–2.5 mm. longa, 1 mm. lata, fusco-purpurea, *cochleariformia, latissime ovata, brevissime acute acuminata*, apice nonnunquam subcucullato, apiculo reflexo. Margines infra fortiter recurvi, integri. Costa ad basin sat valida, purpurea, *sub apice soluta*. Cellulae superiores *angustissime rhomboideae, fusiformes*, parietibus *valde incrassatis*, saepe porosis, ad margines haud mutatae, versus basin longiores, angustiores, basilares purpureae, paullo latiores, lineares vel rectangulares, seriebus rectis, parietibus transversalibus angustis, longitudinalibus valde incrassatis, porosis. Meerendal, 4000–4100 m., Mt. Carstensz; coll. *Wissel, 29;* (BZ, 4006).

A remarkable species, in habit somewhat approached by the South Indian *B. pachycladum* Card., but quite different in the areolation from any species known to me; the cells indeed are so narrow and incrassate that it is not absolutely certain that it can belong to *Bryum*.

## BARTRAMIACEAE

**Bartramia** (Vaginella) **cubica** Dix. sp. nov.

Robusta, olivaceo-viridis, caules ad 5 cm. alti, *densifolii;* folia sicca erecto-patentia, stricta, e basi erecta, albida, *late oblonga, superne dilatata*, abrupte lanceolato-subulata; margines plani, *brevissime*, conferte; subula fortius denticulati; costa superne angusta, difficiliter distinguenda; cellulae elongatae, obscurae, conflatae, dorso dense, *grossiuscule verrucosae*. Seta circa 1 cm., arcuata, sat crassa; theca immatura *cubica*, 1.5 mm. longa; operculum umbonatum. Fructus unicus visus. Zuidwand, Geele Dal, Mt. Carstensz, 4500–4700 m.; coll. *Wissel, 65.* **type.** Ibidem (*66*); (BZ. 3999b, 3998).

The single capsule is immature, but on boiling the seta remains arcuate, and the capsule takes a distinctly cubic form, so that I think it may be

assumed that these characters are normal. They recall *B. quadrata* Hook. from South Africa, but on a much more robust scale.

The genus has not been recorded from New Guinea hitherto.

**Philonotis Thwaitesii** Mitt.

Prope Port Moresby, Papua, 1935; coll. *Carr, 12399.* New to New Guinea. DISTR.: Ceylon.

**Breutelia Römeri** Fleisch.

Meerendal, Mt. Carstensz, 4000–4100 m.; coll. *Wissel, 4;* (BZ, 3991).

This fine species has, I believe, only been collected before in the original station.

## HYPNODENDRACEAE

**Sciadocladus novae-guineae** Dix. sp. nov.

Stirps pulcherrima, 10–15 cm. alta et ultra, laete ochracea, subnitida, fronde flabellata, bipinnata, complanata usque ad 10 cm. longa, 4 cm. lata stipitem strictam simplicem 5 cm. longam terminante. Folia stipitis conferta, magna, longa, arcte appressa, *longe acute acuminata.* A *S. celebensi* Dix. fronde *multo longiore, latiore, complanata, pinnata,* flavida, foliis *brevius,* acuminatis, dentibus marginalibus multo *brevioribus, confertioribus,* cellulis paullo angustioribus, alaribus haud diversis, seta *breviore,* differt. Seta 2–3.5 cm. alta; theca suberecta vel inclinata, laevis, superne leniter angustata, deoperculata usque ad 8 mm. longa, operculo acuto, conico-curvirostro. Supre Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 14184,* **type.** Gunong Goh Lemboeh, Gajolanden, Atjeh, Sumatra, 3000 m., summit zone, 22 Feb. 1937; coll. *van Steenis, 10201;* (BZ, 4046). . .

**Sciadocladus Wisselii** Dix. sp. nov.

Habitus formarum robustiorum *S. Kerrii* (Mitt.) Jaeg., sed rigidior, crassior. Stipes 7–8 cm. altus, ad basem tantum tomentosus, foliis confertis, fuscis, *magnis, latis,* amplexantibus, appressis, *acutis nec acuminatis,* obtectus. Rami in capitulo densissimo, circa 3–4 cm. lato, congesti, *crassi, obtusi,* vix nitidi, parce, breviter ramulosi. Folia circa 3 mm. longa, late cordato-ovata, *breviter* acutata, fere a basi dense, *fortiter sed haud argute* dentata. Costa validiuscula, sub apice soluta, supernè leniter sinuosa, dorso *parcissime, argute spinosa;* cellulae parvae, breviter angustissime lineares, laeves, infimae laxiores. Cetera ignota. Grassy slopes, Dajakweide, Mt. Carstensz, 3800–4300 m.; coll. *Wissel, 138;* (BZ, 3993).

Somewhat resembling robust, stout forms of the New Zealand *S. Kerrii,* but differing from that and other allied species in the dense, very shortly pointed stiped leaves, giving the stem a stout appearance. From *S. celebensis* Dix. it differs in the much stouter, straighter branches, the leaves much shorter and broader in the points, and the toothing of the margins, which is much closer, and not at all spinulose. *S. novae-guineae* is totally different.

**Mniodendron Hellwigii** Broth.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13021.*

LEUCODONTACEAE

**Forsstroemia rigida** Dix. sp. nov.

Ab omnibus speciebus cum foliis costatis differt foliis siccis dense *imbricatis, appressis,* valde plicatis, *fortiter carinatis, marginibus fortiter recurvatis et undulatis.* Robusta; caules pinnati, 3–5 cm. alti, ramis *longis, teretibus,* subsimplicibus. Folia e basi late ovata, ad insertionem valde contracta, sensim acute sed haud anguste acuminata, *valde plicata,* marginibus *planis, undulatis,* inferne minute, apud apicem urgute grossiuscule dentatis. Costa sat valida, *paullo sub apice* soluta. Cellulae minutae, distinctae, pellucidae, incrassatae, irregulares, plerumque brevissime ovales, marginales saepe 2–3-seriebus *elongatae, angustae,* inferne sensim paullo elongatae, basilares breviter lineares, sigmoideae, ad insertionem flavae. Propagula filamentosa fasciculata axillis foliorum rameorum superiorum saepe inveniuntur.

Perichaetii folia longe, stricte acuminata, appressa. Seta circa 2 mm. longa; theca vetusta elliptica, ore contracto; gymnostoma videtur. Supra Port Moresby, Papua. 1600–2100 m., 1935–36; coll. *C. E. Carr, 13559.*

A very distinct species, in habit and leaf structure, but especially in the foliation when dry; the leaves are closely appressed, and are strongly plicate, partly through the carinate nerve and much reflexed borders, and these being at the same time strongly undulate the resulting appearance is very marked and peculiar.

CYRTOPODACEAE

**Bescherellea Cyrtopus** F. Mull.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13305.* Not var. *papuana* Broth. & Geh., in fact a rather small form.

PRIONODONTACEAE

**Neolindbergia falcifolia** Dix. sp. nov.

Robusta; rufescens; caules curvati, densi, hic illic ramosi, ramis *densifoliis, foliis fortiter falcato-secundis,* eis *N. rugosae* forma subsimilibus sed longius, tenuis, *canaliculato-acuminatis;* rugosis, integerrimis, marginibus *arcte angustissime recurvis.* Costa *sinuosa,* supra multo attenuata, circa ⅔ folii altitudinem aequans. Cellulae brevissime lineares, angustae, per totum folium subaequales nisi ad angulos ubi multo breviores, seriebus plurimis irregulares, parietibus sinuosis. Fructus ignotus. Zuidwand, Geele Dal, Mt. Carstensz, 4500–4700 m., coll. *Wissel, 58;* (BZ, 4000).

A very distinct species in the red color, and strongly falcate leaves. This and the undulation of the leaves gives it somewhat a resemblance to some forms of *Trachypodopsis auriculata.*

TRACHYPODACEAE

**Trachypus perplicatus** Dix. sp. nov.

Robustus; *atrofuscus.* Caules rigidi, intertexti, dense irregulariter pinnati, densifolii, ramis plerumque sat brevibus, obtusis, turgidis. Folia sicca rigide patula, *profunde plicata, fortiter undulata,* magna, circa 4 mm. longa, e basi lata, cordata, minute auriculata, sensim in acumen longum, filiformi-cuspidatum, *fortissime undulatum,* minute denticulatum angustata; costa ad basem sat valida, medio folio in plica condita desinens. Cellulae omnes perangustae, lineares, valde incrassatae, *per papillas humiles, seriatas, omnino tectae perobscurae;* versus basem pallidiores, longiores,

minus minus papillosae, conflatae, incrassatae. Cetera ignota. Meerendal, Mt. Carstensz, 4000–4100 m.; coll. *Wissel, 14;* (BZ, 3987).

The areolation, composed of extremely narrow cells, the walls entirely covered, and hidden by the dense, seriate papillae, is similar to what is found in some of the Meteoriaceae, as well as in Trachypodaceae, and the strongly undulate leaves also suggest *Aerobryopsis*. The robust, rigid habit, however, and the rather broad nerve, seem to indicate *Trachypus*, and I have no doubt that it belongs to that genus, of which it is one of the most robust, and most remarkable members.

## PTEROBRYACEAE

**Endotrichella arfakiana** C. Müller

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13309 bis.*

**Endotrichella Campbelliana** Hampe.

On branches of trees in forest, Koitaki, Papua, circa 400 m., 6 May, 1935; coll. *C. E. Carr, 12174.*

**Garovaglia Pauerlenii** (Geh.) Par.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13309* p. p.

**Garovaglia papuana** Dix. sp. nov.

Stirps habitu fere *Endotrichellae elegantis*, sed gracilior, foliis brevioribus, laxioribus, *divergentibus*. Caules secundarii rigidi, lignosi, atro-fusci, per destructionem foliorum plerumque nudi. Folia *laxe patentia, complanata*, 2.5–3 mm. longa, 1 mm. lata, *angusta, oblonga, sensim breviter acuminata*, acuta, longitudinaliter plicata, marginibus planis, (uno latere ad basem saepe breviter recurvato), parte superiore argute sat regulariter dentatis; *ecostata*. Cellulae anguste lineares, *sigmoideae*, finitibus rotundatis, parietibus sat tenuibus sed ad apices cellularum conspicue incrassatis, ad basem longiores et paullo latiores, ad insertionem *aurantiacae*, alares *vix ullae*.

Perichaetium in ramulo brevi terminale, majusculum, bracteis thecam amplexantibus, et arista robusta dentata longe superantibus. Theca subsessilis, elliptica, ad orem paullo everta. Peristomii dentes flavidi, tenues, papillosi, lanceolati, processus *capillares, nodosi, laeves*, aequilongi. Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13605.*

Distinct in the narrow, oblong leaves, gradually shortly acuminate, not cuspidate, the plane margins, absence of nerve and alar cells. The toothing of the leaves is regular, and usually consists of stronger teeth alternating with minute, intermediate ones.

**Garovaglia subintegra** Dix. sp. nov.

Sat robusta, *densifolia*, vix complanata. Folia ab insertione contracta, amplexicauli, ovato-oblonga, *haud acuminata, abrupte breviter tenui-cuspidata*, profunde plicata, ecostata, marginibus *planis, prope apicem tenerrime inconspicue denticulatis;* cuspide sparse denticulata. Cellulae anguste rhomboideae, ad apices incrassatae, ad angulos folii seriebus pluribus *laxae, pellucidae, numerosae*, alas notatas instruentes.

Fructus generis. Bracteae perichaetii *integrae vel subintegrae.* Peristomium fere omnino destructum. dentes papillosos, processus lineares, *fuscos, dense papillosos* exhibens. Spori magni. On branches of forest trees, Koitaki, Papua, circa 450 m., 6 May, 1935; coll. *C. E. Carr, 12124b.*

Not remarkable in habit, or leaf form, but structurally distinct in the margins, very finely and inconspicuously denticulate at apex only.

NECKERACEAE

**Orthorrhynchium philippinense** (Hampe) C. Müller

Low down on tree trunks in wood by stream, Koitaki, Papua, circa 400 m., 19 Apr. 1935; coll. *C. E. Carr, 11944.* New to New Guinea. DISTR.: Philippines; Malay Peninsula. (Perlis, isthmus south of Siam); East Java (coll. *Johannes Gandrup,* 1922). I received the Perlis plant under the name of *O. Ridleyi* Broth. sp. nov., but I am unable to separate it from the Philippine species.

**Himantocladium cyclophyllum** (C. Müller) Fleisch.

Rouffaer Rivier, Dutch New Guinea, Sept. 1926; coll. *Docters van Leeuwen, 10183C,* c. fr.

Two fruits were found; the plant has hitherto been known only in the sterile state. Seta very short, about equalling the capsule, circa 1 mm. long; perichaetial bracts divaricate, short, ovate-acuminate. Capsule erect, elongate elliptic, brown. Peristome well developed. Operculum not seen.

HOOKERIACEAE

**Daltonia Macgregorii** Broth.

Hellwig-gebergte, Dutch New Guinea, 1700 m., 15 Dec. 1912; coll. *A. Pulle, 689* p. p. I have determined this from the description, but there is hardly a doubt of its identity.

**Hookeriopsis utacamundiana** (Mont.) Broth.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 14185.* This, so far as I am aware, has only once been collected in New Guinea, before.

**Chaetomitrium torquescens** Bry. jav. nov. var. **barbatum** Dix.

Calyptra ad basem breviter. sparse ciliata, ciliis setulosis, supra curvatis. On branches of forest trees, Koitaki, Papua, circa 400 m., 6 May, 1935; coll. *C. E. Carr, 12176.*

The typical form has naked calyptra. The present plant agrees with it in all respects except in having the lower part of the calyptra sparsely hairy with stiff hairs curving upwards from a spreading base.

BRACHYTHECIACEAE

**Cirriphyllum novae-guineae** Dix. sp. nov.

Pallide stramineum, habitu *C. cirrosi* (Schwaegr.) sed *strictius;* irregulariter ramosum, ramis strictis, *teretibus, subjulaceis.* Folia sicca erecta, dense imbricata,

sicca subplicata, *latissime ovata, cochleariformia,* in acumen *longiusculum, lanceolatum, peracutum,* saepe undulatum, contracta. Margines plani, *integerrimi.* Costa *perbrevis,* circa tertiam partem folii aequans, ad insertionem crassa, inde valde attenuata. Cellulae perangustae, versus basem sensim latiores, ad insertionem et praecipue ad alas laxae, pellucidae, breviter ovales. Cetera ignota. Zuidwand, Geele Dal, Mt. Carstensz; coll. *Wissel, 6;* (BZ, 3996), **type.** Dajakweide, Mt. Carstensz; coll. *Wissel, 77;* (BZ, 3997), forma foliis angustioribus, costa saepe obsoleta.

A remarkable extension of the distribution of the genus, which belongs to the temperate alpine zones of both hemispheres. The Himalayan *C. cameratum* (Mitt.) is very different. A Chinese species, *C. subenerve* Dix., has somewhat similar leaves, but much finer points, and very numerous and distinct alar cells.

**Rhynchostegium menadense** (Bry. jav.) Jaeg., forma **gracilis.**

On forest tree, Koitaki, Papua, circa 400 m., 29 Apr. 1935; coll. *C. E. Carr, 12084.* New to New Guinea. DISTR.: Malaysia; New Hebrides.

## SEMATOPHYLLACEAE

**Mastopoma Armitii** (Broth. & Geh.) Broth.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 15033a, 15202.*

**Rhaphidostichum Pullei** Dix. sp. nov.

Habitu *R. percomplanato* Dix. *sumatrano,* subsimile, sed strictius, caulibus nigrescentibus, ramis confertioribus, minus complanatis. Folia forma subsimilia, sed angustiora, minus abrupte acuminata, acumine saepe parce denticulata, marginibus (saepe uno latere tantum) anguste revolutis, argute denticulatis; cellulae angustissime lineares, laeves, alares pulchre fusco-purpureae. Propagula parva pyriformia substipitata pluricellulareia purpurea in foliorum axillis parce inveniuntur. Fructus ignotus. Dutch New Guinea, 1912–13, ad Ochnaceas; coll. *A. Pulle, 980.*

In the absence of fruit this might be placed almost equally in *Warburgiella,* but it seems clearly allied to *Sematophyllum revolutum* Broth., which Brotherus now places in *Rhaphidostichum.* It differs from that species in the much more flexuose, finely pointed leaves, with longer, narrower cells, much more distinct alar cells, more distinctly revolute margins, toothed acumen, etc.

**Warburgiella leptocarpa** (Schwaegr.) Fleisch.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13581.* New to New Guinea. DISTR.: Wide in Malaysia; Ceylon; South India.

**Warburgiella subpapuana** Dix. sp. nov.

*W. papuana* Reimers (Hedwigia **69:** 127) peraffinis. Differt habitu *robustiore,* foliis haud pennaeformiter patentibus sed *fortiter falcato-secundis* (*Trichosteleum hamatum* referentibus), atque marginibus *longe infra subulam* denticulatis, subula ipsa *fortius,* perargute denticulata. Cellulae alte papillosae. Seta 2 cm. alta, paullo crassior, *omnino laevis.* Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13872,* **type.**

Very near to *W. papuana* Reimers, but differing quite distinctly in the characters emphasized above.

**Acroporium diminutum** (Brid.) Fleisch.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 15033b*, c. fr. New to New Guinea. DISTR.: Malay Is.; Philippines; Malay Peninsula; Siam, Laos.

**Taxithelium nepalense** (Schwaegr.) Broth.

On decayed log in forest, Koitaki, Papua, near sea level, 5 Feb. 1935; coll. *C. E. Carr, 11142.* New, I believe, to New Guinea. It has a very wide distribution in South-east Asia.

This may possibly be the *T. selenithecium* of C. Müller, but, if so, it certainly cannot be separated from *T. nepalense.* Fleischer, indeed, separates the two mainly on the ground of the latter having the seta rough above, but this is an error, as C. Müller describes it as having "pedunculo laevi."

**Taxithelium nitidulum** Broth. & Par.

On branches of forest trees, circa 400 m., Koitaki, Papua, 6 May, 1935; coll. *C. E. Carr, 12176b.* New to New Guinea. DISTR.: New Caledonia. A little more robust than the New Caledonian plant, but otherwise agrees well.

**Taxithelium capillarisetum** (Dix.) Broth.

Rouffaer Rivier, Dutch New Guinea, on *Eugenia*, Sept. 1926; coll. *Docters van Leeuwen, 10183c* p. p.

**Taxithelium novae-guineae** Dix. sp. nov.

*T. glossoidei* (Bry. jav.) affine; magis diffusum, percomplanatum, folia apice minus late rotundata, multo tenerius denticulata, cellulae paullo latiores, alares et basilares (serie una) majores; perichaetii folia multo longius sed late acuminata, denticulata, lingulata, patentia. Cellulae laeves vel dorso perindistincte prominentes. Seta juvenilis laevis. Nova Guinea Britannica. Kanosia, on stilt roots of *Rhizophora* in swamp, 22 Feb. 1935; coll. *C. E. Carr, 11470.*

Very near *T. glossoides*, but distinct as described above. *T. dimorphophyllum* Dix. & Herz. is also near it, but has more dimorphous leaves, the dorsal much narrower and more acute, and the perichaetial leaves sharply toothed.

HYPNACEAE

**Ectropothecium laticuspes** Broth.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13057.*

**Ectropothecium dentigerum** Dix.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 14291.*

**Ectropothecium plumosum** Dix. sp. nov.

Dense late caespitosum. Caules prostrati, dense, regulariter, breviter pinnati, anguste plumosi, frondes plures cm. longos, 4–5 mm. latos instruentes. Folia decurvo-falcata, sicca leniter plicata, omnia conferta, caulina ab insertione sensim angustata, oblongo-lanceolate, longe tenuiter flexuose acuminata, e medio argute denticulata; costa nulla. Cellulae latiusculae, basem versus sensim laxiores, basilares late rectangulares, alares sat numerosae, inanes, breviter rectangulares, majusculae. Folia ramea minora, angustiora, subula fortiter argute denticulata.

Dioicum. Perichaetium magnum, bracteis magnis, longe subulatis, subdenticulatis. Seta circa 3 cm. longa, tenuissima; theca parva, sicca sub ore valde constricta, turbinata. Nova Guinea, Rouffaer R., Sept. 1926; coll. *Docters van Leeuwen, 10315;* (BZ, 2605).

A very regularly and prettily plumose species, more slender in habit than *E. Moritzii*, and more like *E. eleganti-pinnatum* (C. M.) The leaves are sharply and rather distantly toothed, not as in *E. Moritzii;* the very thin seta and minute capsule are also distinct. *E. aureum* Dix. has wider leaves and much shorter acumen.

**Vesicularia elegantula** Dix. & Herz.

Supra Port Moresby, Papua, 1600–2100 m., 1935–36; coll. *C. E. Carr, 13057* p. p.

NORTHAMPTON, ENGLAND

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# MOSSES OF PAPUA, NEW GUINEA[1]

EDWIN B. BARTRAM

The mosses collected by Mr. L. J. Brass, botanist with the Fly River Expedition of the American Museum of Natural History, Mr. Richard Archbold Leader, were not numerous but highly interesting in many particulars. The collection comprises thirty species, which are enumerated below, including one new genus, seven new species and one new combination. This series is instructive in that it is probably broadly representative of the moss flora of alluvial regions at low altitudes in the Fly River country of British New Guinea.

The types of the new species are in the author's herbarium and in the Farlow Herbarium of Harvard University to whom I am indebted for the privilege of studying this unusual collection.

## FISSIDENTACEAE

**Fissidens** (Bryoidium) **papuensis** sp. nov. FIG. 1–6.

Dioicus; pusillus; caulis circa 2 mm. altus. Folia 8–10 juga, sicca flexuosa, oblongo-lanceolata, breviter acuminata, ad 1.5 mm. longa, ubique limbata, lamina dorsalis ad basem folii evanida; costa percurrente; cellulae hexagonae, 10–12 μ, parietibus firmis, juxtacostales in lamina duplicati laxae, rectangulares, ad 50 μ longae. Seta geniculata, 4–5 mm. longa; theca erecta, deoperculata 0.5 mm. longa.

Daru Island, Western Division, common in tufts and small mats on wet ground in rain forest, *L. J. Brass, 6436,* April 1936.

Similar to *F. bryoides* Hedw. but distinct in the shorter stems, dioicous inflorescence and the lax elongated juxtacostal cells of the duplicate blades.

**Fissidens** (Semilimbatus) **Brassii** sp. nov. FIG. 7–12.

Dioicus, pusillus, caulis 2 mm. altus. Folia caulina circa 6-juga, sicca erecta, apice incurva, ligulata, rotundato-obtusa, 1 mm. longa, elimbata, lamina dorsalis ad medium folii enata. Folia perichaetialia subsimilia, ad 1.4 mm. longa, lamina duplicati angustissime limbata; costa longe infra apicem folii evanida; cellulae minute hexagonae, haud incrassatae, 7–8 μ. Seta 3–3.5 mm. longa; theca minuta, erecta.

Tarara, Wassi Kussa River, Western Division, on termite mounds in savannah forest, *L. J. Brass, 8753,* Jan. 1936.

A unique species possibly allied to *F. microcladus* Thw. & Mitt. but with broadly rounded perichaetial leaves. The leaf margins are strongly crenulate all around except on the duplicate blades of the perichaetial leaves where they are entire and bordered with two rows of rectangular concolorous smooth cells.

Named for the collector, Mr. L. J. Brass, to whom we are indebted for this highly interesting series of Papuan mosses.

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 181.

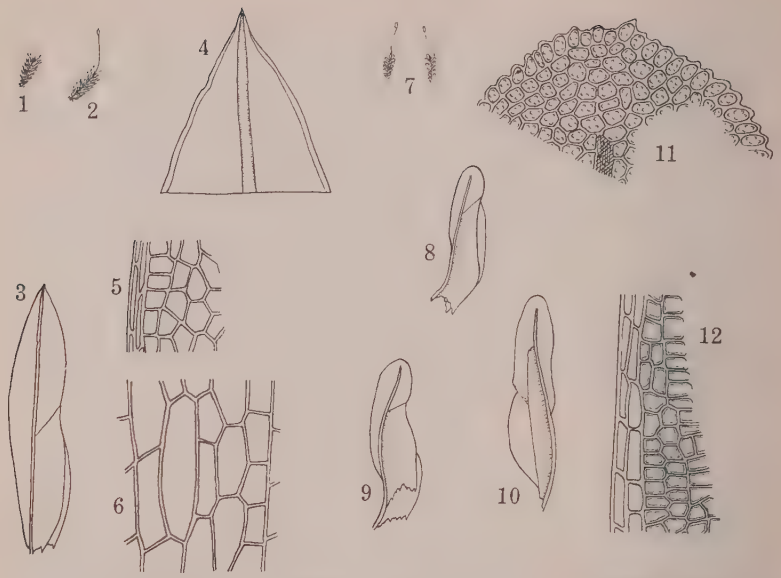


**Fig. 1–6,** *Fissidens papuensis* Bartr. **1,** Male plant × 1.2. **2,** Fertile plant × 1.2. **3,** Leaf × 24. **4,** Apex of leaf × 96. **5,** Cells and margin of apical blade × 300. **6,** Juxtacostal cells of duplicate blade × 300. **Fig. 7–12,** *Fissidens Brassii* Bartr. **7,** Two fertile plants × 1.2. **8–9,** Stem leaves × 24. **10,** Perichaetial leaf × 24. **11,** Apex of stem leaf × 300. **12,** Cells and margin of perichaetial leaf × 300.

## CALYMPERACEAE

**Syrrhopodon** (Cavifolii) **perarmatus** sp. nov. FIG. 13–16.

Gracilis, laxe caespitosus. Caules 1–1.5 cm. alti, ramosi. Folia sicca rigida, patentia, haud crispatula, 2–2.5 mm. longa, e basi oblonga, lineari-lanceolata, acuta, limbata; margines erecti, fortiter spinoso-serrati, in parte superiori vaginae longe ciliato-spinosi; costa percurrente, e media basi usque ad apicem dorso et ventri argute spinosi; cellulae superiores subquadratae, papillosae, haud incrassatae. Caetera ignota.

Palmer River, 2 miles below junction, Black River, *L. J. Brass, 7161a,* July 1936.

The 10–14 cilia at the leaf shoulders are quite distinctive, the longer measuring up to 150 $\mu$ in length. In *S. philippinense* Bartr., an allied species, the armature of the costa is much weaker, the leaves crispate, rounded at the apex and widely different in shape.

**Syrrhopodon albovaginatus** Schwaegr.

Lake Daviumbu, middle Fly River, matted on dead logs in rain forest, *L. J. Brass, 7490,* Aug. 1936. Tarara, Wassi Kussa River, Western Division, rain forest, common, old logs, *L. J. Brass, 8516,* Dec. 1936.

**Syrrhopodon Mulleri** (Doz. & Molk.) Lac.

Palmer River, 2 miles below junction, Black River, abundant on lower trunks of forest trees, *L. J. Brass, 7145, 7161b*, June 1936.

**Thyridium gracile** (Geh.) Broth.

Palmer River, 2 miles below junction, Black River, *L. J. Brass, 7161*, July 1936, trunk of a rain forest tree, 100 m.

**Calymperes daruense** sp. nov. FIG. 17–21.

Caespites densi. Caules ad 1 cm. alti, olivacei. Folia circa 2.5 mm. longa, sicca contorta, humida patentia, e basi brevi ovata oblongo-lingulata, obtusa; margines late inflexi; costa infra apicem evanida; cellulae superiores rotundatae, 6–7 μ, haud incrassatae, leniter papillosae, margines versus angustissime bistratosi; teniola nulla; cancellina parva, supra rotundata, e cellulis 5–7 seriatis, versus marginem multo minoribus. Seta erecta, 1.5 mm. alta; theca cylindrica, 2 mm. longa; calyptra haud rugosa.

Daru Island, Western Division, vivid green moss massed upon and apparently confined to Avicennia 6224 in mangrove forest, *L. J. Brass, 6232*, March 1936 (type). Daru Island, Western Division, *L. J. Brass, 6224A*, 1936.

This species differs from *C. Motleyi*, of the Eurycycla group, as represented by Micholitz no. 210 from Torres Straits, Cape York, in the narrower leaf blade, the broadly inflexed margins with a very narrow thickened border, the smaller lamina cells and the cancellinae in fewer rows, usually only 5 but occasionally 6 or 7 rows.

**Calymperes moluccense** Schwaegr.

Tarara, Wassi Kussa River, Western Division, small cushions, terrestrial, in brushy rain forest, *L. J. Brass, 8679*, Jan. 1937; on bark in mangrove forest, *L. J. Brass, 8547*, Dec. 1936, a form with the teniolae short and faint.

**Calymperes salakense** Besch.

*L. J. Brass, 6709b*, May 1936.

## LEUCOBRYACEAE

**Cladopodanthus heterophyllus** (Fleisch.) comb. nov.

*Schistomitrium heterophyllum* Fleisch., Nova Guinea, Botanique, **8** (4): 739. 1912.

Palmer River, 2 miles below junction, Black River, branch of a forest undergrowth shrub, 100 m., *L. J. Brass, 7148a, 7150*, June 1936.

These collections correspond so closely with the description and illustrations of Fleischer's species that there can be little doubt but that they are the same thing. Fortunately the specimens collected by Mr. Brass are well fruited showing the calyptrae subentire or, at least, not fringed at the base. It is obvious that the species should be transferred to *Cladopodanthus* where it is closely related to *C. muticus* Broth. of Borneo and the Philippines.

**Leucobryum Bowringii** Mitt. var **sericeum** (Broth.) Dix.

Tarara, Wassi Kussa River, Western Division, terrestrial in rain forest, *L. J. Brass, 8543,* Dec. 1936.

**Leucophanes candidum** (Hornsch.) Lindb.

Palmer River, 2 miles below junction, Black River, 100 m., cushion-like mats on branches of forest canopy trees, *L. J. Brass, 7147, 7148b,* June 1936.

BRYACEAE

**Bryum coronatum** Schwaegr.

Tarara, Wassi Kussa River, Western Division, on burnt soil in rain forest, *L. J. Brass, 8544,* Dec. 1936.

ORTHOTRICHACEAE

**Macromitrium semipellucidum** Doz. & Molk.

Palmer River, 2 miles from junct. Black River, branch of a tall forest tree, 100 m., *L. J. Brass, 7149,* June 1936.

**Macromitrium angustifolium** Doz. & Molk.

Palmer River, 2 miles below junction, Black River, upper branches of a forest canopy tree, 100 m., *L. J. Brass, 7146,* June 1936.

HOOKERIACEAE

**Callicostella Karnbachii** Broth.

Fly River, 528 mile Camp, dead stem of a zingiberaceous undershrub in forest, *L. J. Brass, 6709,* May 1936.

**Chaetomitrium orthorrhynchum** (Doz. & Molk.) Bryol. Jav.

*L. J. Brass, 6707a,* May 1936.

**Chaetomitrium acanthocarpum** Bryol. Jav.

Fly River, 528 mile Camp, 80 m., undergrowth shrubs in a gully in forest, *L. J. Brass, 6707;* mats from an undergrowth bush, *L. J. Brass, 6771, 6707a,* May 1936.

BRACHYTHECIACEAE

**Rhynchostegiella papuensis** sp. nov. FIG. 22–25.

Sordide viridis, haud nitida. Caulis repens, dense ramosus, ramis erectis, ad 1 cm. longis. Folia conferta, ovata, breviter acuminata, ubique argute serrata, circa 1.2 mm. longa et 0.5 mm. lata, sicca convoluta; costa valida, supra medium folium evanida, dentiformiter exstante; cellulae lineari-rhomboideae, 5–7 μ. latae et 25 μ. longae, infimae laxae, alares paucae, subquadratae. Folia perichaetialia e basi oblonga sensim in acumen elongatum denticulatum constricta; seta 12 mm. longa, laevis vel superne minutissime scaberrima; theca inclinata, asymmetrica, deoperculata 1.5 mm. longa.

Palmer River, 2 miles below junction, Black River, branches of flood-resistant low trees and shrubs on river bank, 100 m., *L. J. Brass, 7264*, July 1936.

A neat little moss probably near *R. menadense* (Bryol. Jav.) but quite distinct in the shorter and relatively broader leaves, the sharply serrate margins and shorter leaf cells.

ENTODONTACEAE

**Plagiotheciopsis oblonga** (Broth.) Broth.

Palmer River, 2 miles below junction, Black River, silt-fouled trunks of trees on river flood banks, 100 m., *L. J. Brass, 7265*, July 1936.

SEMATOPHYLLACEAE

**Acroporium oxyporum** (Doz. & Molk.) Fleisch.

Palmer River, 2 miles below junction, Black River, branches of a forest canopy tree, 100 m., *L. J. Brass, 7148*, June 1936.

These plants are not typical. The leaves are erect-spreading and the setae nearly smooth above. The short, stout stems are quite different in habit but I doubt if there is any clear specific distinction.

**Rhaphidostichum loriforme** (Broth. & Geh.) Broth.

Palmer River, 2 miles below junction, Black River, matted on tree trunks in wet parts of forest, 100 m., *L. J. Brass, 7302*, July 1936.

**Pseudopiloecium** gen. nov.

Autoicum, robustiusculum, lutescente-viride, nitidiusculum. Caulis irregulariter ramosus. Folia patentia, sicca et humida arcte longitudinaliter plicata; cellulae lineares, laevissimae, incrassatae, alares magnae, vesiculosae. Seta superne scaberrima; theca suberecta, collo mamilloso.

**Pseudopiloecium scabrisetum** sp. nov. FIG. 26–28.

Dense caespitosum. Caulis ad 5 cm. altus, ramis patulis ad 2 cm. longis. Folia conferta, ovato-lanceolata, anguste acuminata, subintegerrima vel superne minute denticulata, plures plicata, 3 mm. longa et 0.6 mm. lata; cellulae omnes anguste lineares, incrassatae, basin versus porosae, alares plures, magnae, hyalinae. Folia perichaetialia minora, subulato-acuminata, marginibus superne lacerato-denticulatis; seta rubra, flexuosa, 1.5 cm. alta, superne arcte papillosa; theca cylindrica, suberecta, collo grosse mamilloso; exothecium e cellulis majusculis, hexagonis, haud collenchymaticis instructum; dentes peristomii dense striolati, linea media leniter sulcata, endostomii membrana alta; calyptra cucullata; operculum oblique aciculato-rostratum.

Palmer River, 2 miles below junction, Black River, matted on tree trunks in wetter parts of forest, 100 m., *L. J. Brass, 7301*, July 1936.

These plants resemble *Piloecium pseudorufescens* (Hampe) C. M. superficially but differ widely in the large undivided alar cells, the setae strongly scabrous above and the capsules tuberculate at the base. The propriety of including this new and suggestive genus in Sematophyllaceae

can hardly be questioned and one cannot well avoid the conclusion that eventually *Piloecium* and possibly *Myurium* will find a more natural alliance in Sematophyllaceae than elsewhere. *Pseudopiloecium* seems to approach *Rhaphidostichum* most closely through the scabrous setae and the tuberculate capsule neck. The exothecial cells are thin walled and show a large, well defined "thin spot" in the center of each cell as is frequently the case in the allied genera.

**Trichosteleum hamatum** (Doz. & Molk.) Jaeg.

Fly River, 528 mile Camp, *L. J. Brass, 6712a,* May 1936.

**Trichosteleum Boschii** (Doz. & Molk.) Jaeg.

Tarara, Wassi Kussa River, Western Division, decaying wood in rain forest, *L. J. Brass, 8545,* Dec. 1936.

**Acanthorrhynchium papillatum** (Harv.) Fleisch.

Fly River, 528 mile Camp, from trunks of small trees in a gully, 80 m., *L. J. Brass, 6711,* May 1936.

**Taxithelium instratum** (Brid.) Broth.

Fly River, 528 mile Camp, from trunks of small trees in a gully, 80 m., *L. J. Brass, 6711a,* May 1936.

## HYPNACEAE

**Isopterygium minutirameum** (C. M.) Jaeg.

Lower Fly River, East Bank, mound on peaty hummocks in swamp forest, *L. J. Brass 8152,* Oct. 1936.

**Ectropothecium longicapillare** sp. nov. FIG. 29–30.

Dioicum? Robustum, pallide aureum, nitescens. Caules ad 4 cm. longi, regulariter densissime pinnati, ramis 6–7 mm. longis. Folia caulina falcata, conferta, valde plicatula, e basi late cordato-auriculata sensim in acumen subpiliformiter dentatum attenuata, circa 2.5 mm. longa; marginibus erectis, e basi fere remote denticulatis; costis binis, longiusculis; cellulae lineares, 5 μ latae, marginalibus haud diversis, infimae laxiores, alares plures, ad angulos magnae, hyalinae. Folia ramea minora, superne fortius denticulata, cellulae alares paucae. Folia perichaetialia abrupte longe piliformiter acuminata, argute serrata; seta 2 cm. longa; theca parva, deoperculata 1 mm. longa, pendula, turgide elliptica.

Palmer River, 2 miles below junction, Black River, on base of tree in wet forest, 100 m., *L. J. Brass, 7303,* July 1936.

The very long strongly toothed leaf acumen is quite distinctive and seems to distinguish this species from any of its numerous allies.

**Ectropothecium Micholitzii** Broth.

Palmer River, 2 miles below junction, Black River, covering a log on river bank, 100 m., *L. J. Brass, 7340,* Aug. 1936.

BUSHKILL
PIKE CO., PENNA.

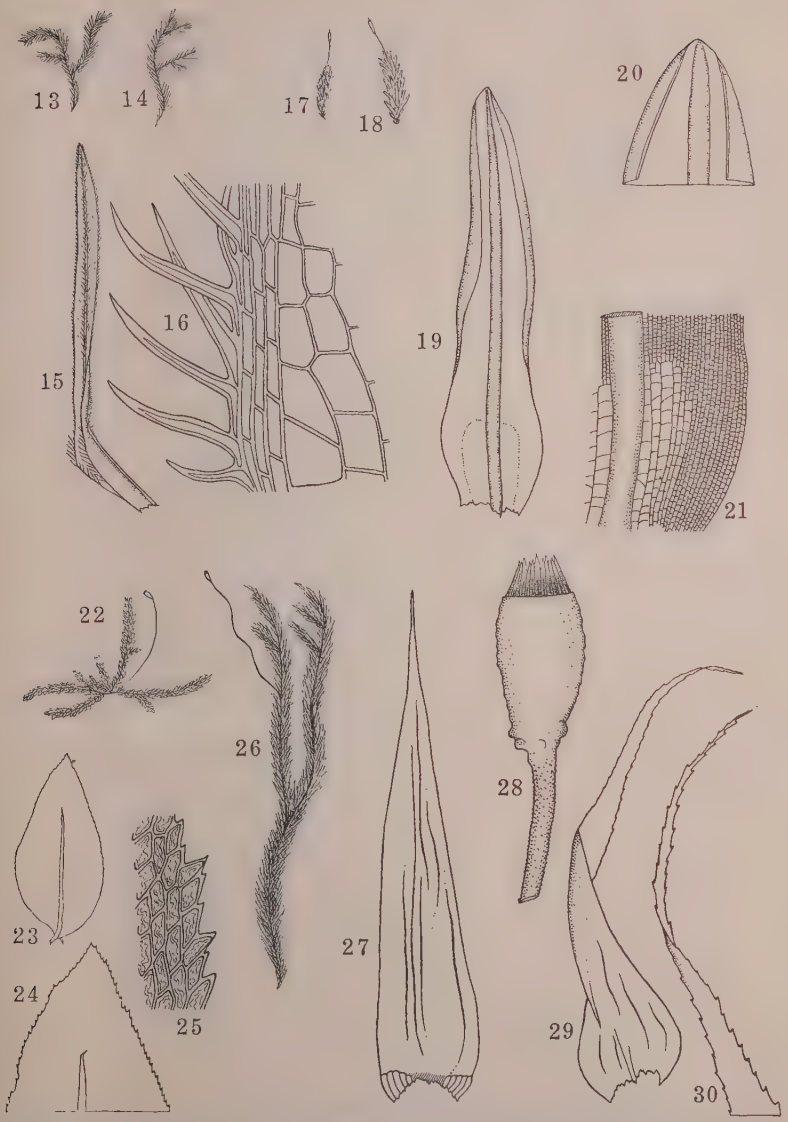


**Fig. 13–16,** *Syrrhopodon perarmatus* Bartr. **13–14,** Plants × 1.2. **15,** Leaf × 24. **16,** Shoulder of leaf base × 240. **Fig. 17–21,** *Calymperes daruense* Bartr. **17,** Dry plant × 1.2. **18,** Moist plant × 1.2. **19,** Leaf × 24. **20,** Apex of leaf × 48. **21,** One side of leaf base × 48. **Fig. 22–25,** *Rhynchostegiella papuensis* Bartr. **22,** Plant × 1.2. **23,** Leaf × 24. **24,** Apex of leaf × 48. **25,** Upper leaf cells and margin × 300. **Fig. 26–28,** *Pseudopiloecium scabrisetum* Bartr. **26,** Plant × 1.2. **27,** Leaf × 20.4. **28,** Capsule × 18. **Fig. 29–30,** *Ectropothecium longicapillare* Bartr. **29,** Stem leaf × 24. **30,** Apex of branch leaf × 48.

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# THE GENERA KICKXELLA, MARTENSELLA, AND COEMANSIA[1]

D. H. Linder

Ever since the genera *Kickxella, Martensella, Coronella,* and *Coemansia* were described, the first and second genus by Coemans (5, 6) in 1862 and 1863, the third by Crouan (7) in 1867, and the last by Van Tieghem (11) in 1873, there has been some doubt as to their taxonomic status as well as in respect to their natural relationships. It is the purpose of this paper to discuss both of these topics and, in addition, to describe the new species that were brought together by the late Professor Roland Thaxter during the many years in which he collected and often grew in culture the members of this interesting group of micro-fungi.

The species of *Coemansia* and the related forms may readily be divided into two distinct types, the first of which is characterized by the fact that the sporocladia or sporogenous branches form a whorl at or just below the apex of the fertile hyphae (Pl. 2B), whereas the second type which represents the majority of species, is characterized by the more disperse arrangement of the sporocladia along the upper portions of the simple or branched fertile hyphae. In addition to these relatively gross differences, there is also the additional one that in the first group the spores possess an incomplete septum that is represented by an annular thickening laid down internally near the middle of the spores.

Representing the first type of conidial fructification, characterized by the whorled arrangement of the sporocladia, is *Kickxella,* which was discovered by Coemans (5) in 1861 at which time he studied it with some care and published his observations in 1862 when he described it as *K. alabastrina.* Of the development of the conidiophores he wrote, "Pour fructifier, ce rhizome [sterile mycelium] émet des stolons ou pédicelles à pointe obtuse, d'abord non cloisonnés, mais qui se gonflent ensuite au sommet en une espèce de globule et se divisent au moyen d'une, de deux ou de trois cloisons. Ces diaphragms, dont j'ai observé l'apparition, se form exactement comme chez les mucorinées. Ce globule, qui ne différait guère jusqu'ici d'une sporange normal, se divise . . .". Unfortunately he continued and described the presence of both mucoroid sporangia and cleistothecia in which asci were formed. However, although he mentioned these extra types of fructifications, he stated quite clearly that he was unable to discover any organic connections between the conidial and the sporangial or cleistothecial stages, although he did remark that in his opinion, the ascigerous stage was probably connected. Coemans' species was again collected and described in 1867 by Crouan (7) as *Coronella nivea.* There is little doubt that the two species were synonymous and that Coeman's name has priority. Yet in 1883, because

[1] Contribution from the Laboratory of Cryptogamic Botany and the Farlow Herbarium of Harvard University, no. 214.

of the fact that Coemans mentioned the connection between the conidial and ascigerous stage, Saccardo (8) arbitrarily erected the genus *Coemansiella* for that stage and transferred the name *Kickxella* to the pyrenomycetous stage which, as already mentioned, was thought to be connected with the conidial phase. This transfer of names would be in accordance with the International Rules of Botanical Nomenclature if the relation between the two stages had been proved beyond a doubt, although the name *Coronella* should have been applied rather than *Coemansiella*, and I believe that it was because of this interpretation of the International Rules, that Torrey (10) in 1921 accepted *Coronella nivea* as valid. It is the writer's opinion that both Saccardo and Torrey were in error in drawing their conclusions and the reasons for this difference of ideas are: 1) that Coemans applied the name *Kickxella alabastrina* to the conidial stage and not to the ascigerous stage, as is witnessed by the fact that there was furnished a very complete description of the development and morphology of the former, and no description worthy of the name for the latter; 2) there was obviously considerable doubt in Coemans' mind whether the conidial stage was a Phycomycete or not, since he mentioned not only the mucoroid development of the conidiophore, but also remarked on the presence of mucoroid sporangia in addition to that of the cleistothecia. He also stated that he could discover no organic connections between the three types of fructification and concluded that he *thought* the conidial and cleistothecial stages were connected. To state an opinion without definite proof does not establish the fact and accordingly Saccardo's action must be considered unwarranted and his establishment of *Coemansiella* when *Coronella* was available is, to state the case mildly, an example of arbitrary juggling of names; 3) the subsequent studies by Van Tieghem and Le Monnier (11) and Beer (4), who were able to obtain the fungus in culture, did not enable them to connect the conidial with any perithecial stage. Thaxter, who was able also to grow *Kickxella* and the related species of *Coemansia* in culture for a number of years, was unable to discover any connection between the conidial and any perithecial stage. It therefore would appear highly improbable that there is any connection between these genera and an ascomycetous stage. Accordingly, as Bainier (3) has pointed out, *Kickxella alabastrina* Coem. must be preserved as the proper name for the fungus.

Representing the second type of conidial fructification, characterized by the pleurogenous and more diffuse production of the sporocladia, are the two genera *Martensella* and *Coemansia* concerning which there has been some confusion. Coemans (6) described *Martensella* as being characterized by having the conidia produced on the upper surface of the sporocladia, while Van Tieghem and Le Monnier (11) described *Coemansia* which was characterized by the spores being produced on the lower surface. Bainier (2) later reported *Martensella pectinata*, but

subsequent studies (3) showed that his species was actually a member of the genus *Coemansia* which he then called *Coemansia pectinata,* but at the same time he made Coemans' species a synonym of his own later species, an action which violated the principle of priority, but pointed out that his species differed from the earlier species in the manner of conidial formation and by the fact that the conidia of his species were 14 $\mu$ long, whereas those of Coemans' species were 8–9 $\mu$. If Bainier distrusted Coemans' description, as he implies very strongly, he should have reduced *Coemansia* to synonymy, and should have described his additional new species in *Martensella* rather than in *Coemansia.* As a result, his treatment of the genus was confusing and noncommittal. Since Coemans' description of *Kickxella* is acceptable, there is no reason from the evidence available why his description of *Martensella* should not be accepted as well, and since *Martensella pectinata* Coem. and *Coemansia pectinata* Bain. are morphologically distinct, not only should the two species be recognized but so also should the two genera.

## MORPHOLOGY AND DEVELOPMENT

The morphology and development of the fruiting structures of the genera discussed in this paper are remarkably similar so far as can be determined from the literature or a study of the species as they grow in nature or in culture. Van Tieghem and Le Monnier (11) and Beer (4) have reported on the germination of the spores of *Coronella* (= *Kickxella*) and have shown that the conidia germinate by means of two germ tubes, one arising from either side of the conidium near the central part of the spore. The germination of the conidia of *Coemansia* has not been observed but it seems probable that germination must be very similar. In any event, it is clear that the resulting mycelium of *Kickxella and Coemansia* are much the same. In both, the radiating mycelium becomes much branched and strongly resembles the developing mycelium of *Rhizopus nigricans,* not only in the fact that the mycelium tends to decrease in diameter towards the periphery of the colony, but also because it remains coenocytic until conidiophore formation begins to take place. In one species which will be noted in the taxonomic portion of this paper, the mycelium does not remain isodiametric or tapering, but becomes more or less gangliform and thus resembles the mycelium of *Mortierella tuberosa* V. Tiegh. as illustrated by Van Tieghem (12). Once the vegetative mycelium has developed sufficiently, conidiophore formation is initiated. The first evidence of this, according to Van Tieghem and Le Monnier (11), is the swelling of the terminal cells of the branched mycelium, although Beer (4) has noted for *Kickxella,* as the writer has observed for certain species of *Coemansia,* that there is a slender fusiform swelling of the mycelium, which becomes separated from the remainder of the hypha by septa at either end. From near the center of the upper side of the fusiform swelling, arises the erect and, as com-

pared with the repent vegetative mycelium, stout conidiophore which elongates rapidly and in most instances remains coenocytic until just prior to the formation of the sporogenous branches. Unlike the other genera, *Kickxella* produces a slight globose swelling at the apex of the conidiophore and this gives the appearance of a potential sporangium, but instead of forming sporangiospores, it proceeds to the formation of nine to fourteen sporogenous branches which are produced in a whorl. These branches have variously been termed sporogenous branches, basidia, prophialides or sporocladia. In *Martensella* and *Coemansia* the apical swelling of the conidiophore is lacking, but like those of *Kickxella*, the conidiophores become septate at about the time of sporocladial formation. In most species examined, the sporocladia appear to be produced acrogenously, but by the continued growth of the main axis of the conidiophore they subsequently take a lateral position and are variously scattered, according to the species, along the length of the conidiophore. The sporocladia as they elongate become inflated near the apex and this inflated portion continues a limited growth. Soon a septum is laid down at the base of the inflated portion and the sporocladium rapidly become differentiated from the sporocladial stipe. In relatively quick succession the first few septa are laid down acropetalously, but subsequently the resulting cells are further subdivided. While this process is going on, small finger-like processes, which become ellipsoidal or elongate-ellipsoid are produced on the upper side of the sporocladium in *Kickxella* and *Martensella*, or on the lower side in *Coemansia*. These structures, also formed acropetalously, and arising from all but one or two terminal cells which remain sterile, are the phialides which in turn produce a very slender sterigmatoid process on the end of which is borne a spore. Thus the life-cycle, as far as the asexual stage is concerned, is completed. Throughout the development of the forms, one is struck by the close resemblance of nearly all stages to comparable stages in the Zygomycetes.

## NATURAL RELATIONSHIPS

The natural relationship of these forms, as has been mentioned earlier, has been a subject of debate, and, as in *Kickxella*, has an important bearing on the taxonomy of the members. Without exception, the various authors mention their resemblance to the Mucorales, both because of their habitat and their manner of growth, but after acknowledging these resemblances, they nevertheless placed these fungi in the Hyphomycetes where they were considered to form a more or less special group. Thaxter (9) in mentioning a new species of *Martensella* in his paper on *Syncephalastrum* and *Syncephalis*, stated that the genus belongs in the Zygomycetes. No reason was given for the assertion, but because of Dr. Thaxter's wide knowledge of many interesting and unusual Zygomycetes, it is obvious that this statement was not based wholly on the close resemblance of *Coemansia* and the related genera to the members of the Mucorales. Evidence that his conclusions were better founded is fur-

nished by his collection in which there is a slide and dried culture labeled "from Sphagnum zygospores, Kittery Point, Maine," thus indicating that he had not only seen the zygosporic stage, but also had made cultures from which he obtained the *Coemansia* or conidial stage. Unfortunately he left no notes or drawings to show what the structure and morphology of the zygospore might be, although an additional slide was found, in a dried condition, that was labelled "An attempt at zygospore formation." When the slide was restored, it was found that he did indeed have a structure (Pl. 4 I) that not only could be called an "attempt at zygospore formation," but which actually was a zygospore even though in an early stage of development. If this type of zygospore is identical with the one from which he was able to obtain the culture from which he made the specimen labelled "From Sphagnum zygospore, Kittery Point, Maine," and there appears to be little doubt that such is the case since the data are the same, then there is furnished the explanation of Thaxter's firm belief in the zygomycetous affinity of *Coemansia* and related genera.

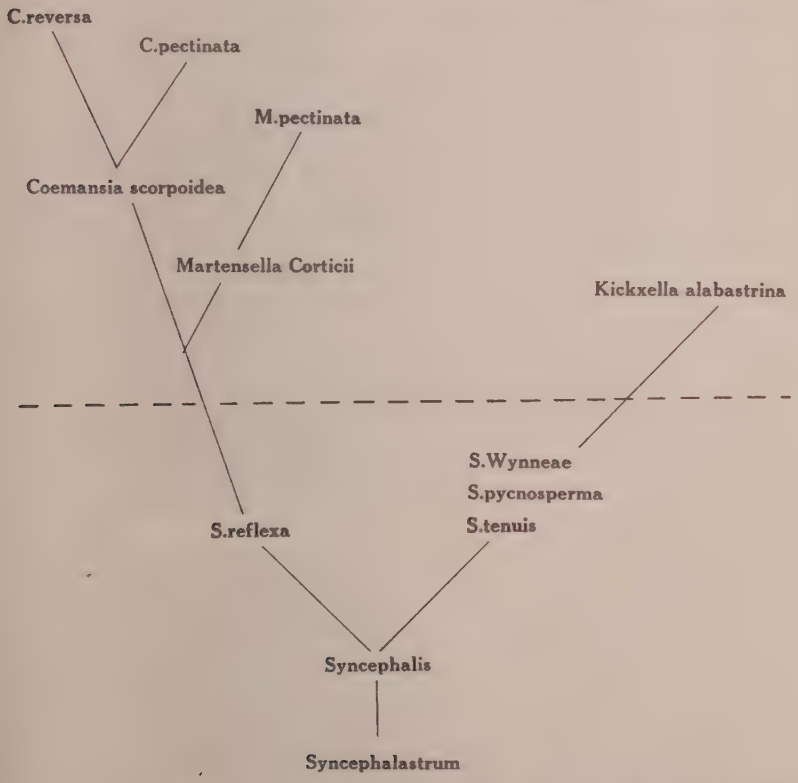
In contrast to Thaxter's opinion is that of Ayers (1) who, in 1935, while studying the range of parasitism of *Dispira cornuta* Van Tieghem, found that this fungus did not attack *Coemansia reversa*, nor did it attack certain species of *Mortierella* or *Piptocephalis*, although it did attack a long list of genera and species in the Mucorales. While pointing out that this species can parasitize only members of the order Mucorales and in discussing the lack of ability of *Dispira* to parasitize *Coemansia reversa*, he concludes that "Although the negative evidence is of course not conclusive, it seems to indicate that *C. reversa* is probably not one of the Mucorales." That the negative evidence is not conclusive, is shown by the fact that *Mortierella* and *Piptocephalis*, admittedly members of the Mucorales, also are not attacked.

The reasons for not considering *Kickxella*, *Martensella* and *Coemansia* as members of the Zygomycetes seem to lie in the fact that Coemans reported a cleistothecial stage as doubtfully connected with *Kickxella*, that *Dispira* does not parasitize *Coemansia reversa*, and finally, that the complicated nature of the spore-bearing structures appears to rule out such a relationship. In favor of the zygomycetous relationship of these three genera is their truly mucoroid morphology and development, especially in the early stages, and the evidence furnished by Thaxter's herbarium notes that he had obtained *Coemansia* by culturing zygospores that he had collected in Kittery Point, Maine. While the writer has no reason for questioning the accuracy of Thaxter's statement, in view of the conflicting opinions that have appeared in the literature, it is realized that his results will have to be repeated under controlled culture conditions before the zygomycetous nature of the forms under consideration can be proved. However, until this can be done, there is no reason for not placing them tentatively in the Zygomycetes if it can be shown on morphological grounds that they rightfully belong there.

The resemblance of the Coemansia-like forms to the Mucorales has already been frequently mentioned, but when these forms are compared with the members of the Cephalideae that are described in Thaxter's paper, the analogy of the structures becomes more striking. Using *Kickxella alabastrina* as an example in comparing the forms, it is evident that the development of the conidiophore follows closely that of the conidiophore of species of *Syncephalis* up until the time of formation of the sporocladia. The presence of septations at this stage of development (i. e. just prior to the formation of the sporocladia) can not be considered as too significant since they are also found in *Piptocephalis* and *Chaetocladium* which are admittedly Zygomycetes. It is with the further development of the sporocladia, that difficulties enter in correlating that structure with those found in *Syncephalis*, but the difficulties seem to the writer more apparent than real. The sporocladial branches of *Kickxella* may well be compared with the secondary sporophores of *Syncephalis Wynneae* Thaxt. and *S. pycnosperma* Thaxt. except that they are arranged in whorls in the former and are clustered over the apex of the slightly swollen conidiophore in the two latter species. The nature of the secondary sporophores of the two species of *Syncephalis* has been clearly exposed by Thaxter (l. c. p. 9) who concludes that the secondary sporophore, the counterpart of the sporocladium, has been derived from the "spore rows" or seriate sporangia by the differentiation of the sporangium into a sterile basal and a fertile apical portion. Thaxter thus follows Van Tieghem's (12) ideas of the evolutionary lines within the Cephalideae by deriving the single spored sporangium from the many-spored seriate type. Having thus derived the secondary sporophore, there remains now the problem of deriving the sporocladium and the other structures that are characteristic of *Kickxella*. It has been seen that in the Syncephalidaceae the trend has been towards a specialization of parts. In *Kickxella* through the intervention of septation, this specialization has been carried further. The secondary sporophores of *Syncephalis* have become arranged in a whorl around the apex of the conidiophore, but in addition they have become septate, and since at this stage of evolution exogenous spore production has become a fixed character, it becomes necessary if the advantages of septation are not to be lost, that further structures be formed for the production of increasing numbers of spores, and such structures are the phialides. On each cell, but the one or two terminal cells which are sterile, are produced four or more phialides that in turn bear conidia. Thus, by the radial arrangement of the sporocladia and by their septation, there has resulted a greatly increased spore-bearing surface, and *Kickxella* represents the logical culmination of a line of evolution which starts with a form like *Syncephalastrum racemosum* and passes through stages represented by *Syncephalis tenuis*, *S. pycnosperma* and *S. Wynneae*.

It is possible that *Coemansia* and *Martensella* may have been derived

from *Kickxella*, but the diffuse arrangement of the sporocladia would indicate another starting point which is to be found in *Syncephalis reflexa* V. Tiegh., illustrated in the paper by Thaxter already cited. In this species, the apex of the sporangiophore becomes inflated and the inflated portion bends and bears the spores on the under surface. At the stage of development shown in Thaxter's figure 14, the sporogenous,




inflated zone is definitely comparable to the sporocladium of a simple species of *Coemansia*, although it lacks the septation and does not produce phialides. As the young sporangia of *S. reflexa* mature, they become three-celled, whereas in *Coemansia* the sporangia remain one-celled, that is, a conidium. Thus by applying Van Tieghem's theory as amplified by Thaxter, *Coemansia* may be considered to be a group in which the seriate sporangium has become differentiated into a basal stalk cell or phialide, and a terminal reproductive cell or conidium, and the only difference between *Coemansia* and *Syncephalis* is in the lack of septation of the recurved, swollen sporangiophore of the latter. Just

as *Kickxella* shows evidence of modification for the production of greater numbers of spores, so too do the species of *Coemansia*. The next logical step along this line is illustrated by *Martensella Corticii* and *Coemansia ceylonensis* and *C. scorpoidea* (Pl. 3A, C and D) which are to be described subsequently. *Martensella Corticii* is apparently not far removed from *S. reflexa* since the sporocladia are few in number, rarely as many as three, and are few-septate. In the early stage of development, the fruiting structure strongly resembles *S. reflexa*. The conidiophore is once-septate and is terminated at first by a single sporocladium, but as this reaches maturity, the axis of the conidiophore continues to grow, the sporocladium is pushed to one side, and a second sporocladium is produced. In other words, proliferation has taken place, and correlated with that process has been the increase in the degree of septation, a statement that may be readily confirmed by a study of the figures accompanying the present paper. The further differentiation of the forms with a diffuse arrangement of the sporocladia is merely a matter of a change in the orientation of the phialides on the sporocladia.

From the above diagram, it can be seen that it is the writer's opinion that the *Coemansia*-like fungi fall into two main groups which have their common source in the Syncephalidaceae in the genus *Syncephalastrum*. Because of the close relationship shown by their morphology, there seems no real reason for placing these forms in the Fungi Imperfecti while considering *Syncephalastrum* and *Syncephalis* to belong in the Zygomycetes. Therefore the new family, **Kickxellaceae** is proposed for inclusion among the Zygomycetes, and is defined as follows:

**KICKXELLACEAE,** fam. nov.

Fungi hyphis fertilibus erectis vel adscendentibus, simplicibus vel ramosis, septatis, hyalinis vel laete coloratis, sporocladia gerentibus; sporocladiis septatis, hyalinis, inflatis et cellulis sterilibus, 1–2, terminatis; vesiculis sporigeris (phialides) simplicibus, unicellularis, hyalinis, ovoideis vel elongato-ellipsoideis, in superficie aut infra aut supra sporocladii productis; conidiis simplicibus vel pseudo-uniseptatis, hyalinis vel luteis, elongato-ellipsoideis, fusoideis, vel acicularis.

Fungi with erect or ascending fertile hyphae, septate, simple or branched, hyaline or light colored, and bearing sporocladia. Sporocladia somewhat inflated, septate, and frequently tapering to the one to three terminal cells. Phialides borne on the upper or the lower surface of the cells of the sporocladia, simple, hyaline, ovoid to elongate-ellipsoid. Conidia borne acrogenously on the phialides, non- or, in *Kickxella*, pseudoseptate, hyaline to yellow, elongate ellipsoid, fusoid, or needle-shaped.

The type genus is *Kickxella* Coemans.

KEY TO THE GENERA AND SPECIES OF THE KICKXELLACEAE

1. Sporocladia in a whorl at the apex of the conidiophore; conidia pseudo-septate. **KICKXELLA** ..... **1. Kickxella alabastrina**

1. Sporocladia pleurogenous; the conidia not pseudoseptate ..... 2
2. Sporocladia bearing conidia on the upper surface. **MARTENSELLA** 3
2. Sporocladia bearing conidia on the lower surface. **COEMANSIA** ..... 4
3. Conidiophores more than 200 μ long, sporocladia 9–11-septate. **2. Martensella pectinata**
3. Conidiophores less than 200 μ long; sporocladia 2–5-septate; on Corticium spp. ..... **3. Martensella Corticii**
4. Conidiophores less than 500 μ long ..... **4. Coemansia ceylonensis**
4. Conidiophores more than 500 μ long ..... 5
5. Conidiophores spirally twisted ..... **5. Coemansia spiralis**
5. Conidiophores not spirally twisted ..... 6
6. Sporocladial stipe 15 μ or less in length; sporocladia close together on the conidiophore; conidiophores bi- or trifurcate or occasionally simple ..... 7
6. Sporocladial stipe 15 μ or more in length; sporocladia distant on the conidiophore; conidiophores simple or branched below the fertile region ..... 13
7. Parasitic on *Isaria;* sporocladia recurved ..... **6. Coemansia reversa**
7. Not parasitic on *Isaria;* sporocladia not conspicuously recurved ..... 8
8. Conidia acicular or fusoid-cylindrical and pointed at the apex ..... 9
8. Conidia fusoid or elongate, rounded at the apex ..... 10
9. Conidiophores trifurcate or bifurcate in fertile part, the resulting branches short ..... **7. Coemansia breviramosa**
9. Conidiophores simple or rarely bifurcate in the fertile part; the sporocladia in successive groups 8–15 on the conidiophore. **8. Coemansia interrupta**
10. Conidia 6.5–11 μ long; conidiophores mostly trifurcate above. **9. Coemansia erecta**
10. Conidia 10.5 μ or longer; conidiophores mostly bifurcate above ..... 11
11. Conidiophores repeatedly bifurcate ..... **10. Coemansia kamerunensis**
11. Conidiophores mostly once bifurcate above ..... 12
12. Conidia 10.5–12.5 μ long; sporocladia 8–12-septate, arcuate or somewhat spirally ascending, the sterile apical cell recurved. **11. Coemansia braziliensis**
12. Conidia 12.5–14.5 μ long; sporocladia 6–7-septate, nearly straight but angularly bent at the basal cell so that the sporocladia nearly parallels the main axis of the conidiophore ..... **12. Coemansia guatemalensis**
13. Conidia acicular, 14.4–18 x 1.5 μ ..... **13. Coemansia aciculifera**
13. Conidia elongate or fusoid with rounded apices ..... 14
14. Sporocladia 1–5, produced scorpioidally ..... **14. Coemansia scorpioidea**
14. Sporocladia more numerous and not borne scorpioidally ..... 15
15. Conidia 18–23.5 x 2 μ ..... **15. Coemansia Thaxteri**
15. Conidia less than 18 μ long ..... **16. Coemansia pectinata**

**KICKXELLA** Coemans, Bull. Soc. Roy. Bot. Belgique **1**: 155–159. *l pl.* 1862.

*Coronella,* Crouan & Crouan, Florule d. Finistere p. 12. supplem. *fig. 21.* 1867. *Coemansiella* Saccardo, Syll. Fung. **2**: 815. 1883; ibid. **4**: 55. 1886.

The generic characters are those of the family except that the sporocladia are formed in an apical whorl around the somewhat inflated apex of the conidiophore, and the phialides are borne on the upper surface of the sporocladia.

The type and only species is *Kickxella alabastrina* Coemans.

**1. Kickxella alabastrina** Coemans, *l. c.*

*Coronella nivea* Crouan. *l. c.*
*Coemansiella alabastrina* Saccardo, *l. c.*

PLATES 2B; 4P.

Colonies whitish or pale cream color in mass. The conidiophores at first simple and fruiting when about 500 $\mu$ long, later cymosely branched and attaining a length of approximately 2 mm., few and distantly septate, hyaline, 30–35 $\mu$ in diameter at the base, slightly tapering upwards to 18–22 $\mu$ just below the bulbous enlargement at the apex which is 27–36 $\mu$ in diameter. The sporocladia produced in a whorl around the bulbous apex of the conidiophore, 9–12 –(14) in number, 70–81 x 10.5–12.5 $\mu$, (1)–2–3–(5) septate, the terminal cell or cells sterile, mostly forked, rarely simple, upcurved, the branches of the ultimate cell somewhat recurved. Phialides ovoid or elongate-ovoid, mostly 6–6.5 x 3.5 $\mu$. Conidia hyaline, elongate ellipsoid or somewhat tapering towards the ends, 10–12–(16.2) x 4.5 $\mu$, frequently with a pseudoseptum or internal annular thickening of the wall near the central part of the spore.

Specimen examined: MAINE, Kittery Point, on horse dung, Aug.–Sept. 1895, *R. Thaxter* (Acc. no. 765).[2] Also reported from Belgium, France, and England.

The taxonomy and nomenclature of this species has already been discussed in the earlier pages of this paper. Beer (4) in discussing the germination of the conidia of this species, has noted that at the time the germ tubes arise, one from either side of the spore, there is a pronounced bulging of the conidium near the center. It seems quite possible that this bulging area is correlated with the presence of the pseudoseptum and actually represents a modification of that structure brought about by the activities within the cell just prior to germination. In connection with the postulated origin of the genus from *Syncephalis*, it is interesting to speculate on the significance of the annular thickening of the wall since it is strongly reminiscent of the early stage of the delimitation of the three spores in the seriate sporangium of *Syncephalis* as figured by Thaxter (9). The fact that the annulus is laid down, and also that the spore germinates by two germ-tubes, suggests the possibility that the conidium of *Kickxella alabastrina* represents a reduced two-spored sporangium. If this is so, another bit of evidence is added to support the relationship between *Kickxella* and *Syncephalis*.

**MARTENSELLA** Coemans, Bull. Acad. Roy. Belgique ser. II. **15**: 536–540. *pl. 1–2.* 1863.

The generic characters are those of the family except that the sporocladia are diffusely arranged along the conidiophores, the phialides are produced on the upper surface of the sporocladia. Type species *M. pectinata* Coemans.

**2. Martensella pectinata** Coemans *l. c.*

Colonies white or yellow from the spores. The conidiophores solitary or in clusters, simple or irregularly branched, distantly septate,

[2] All specimens that have been examined are deposited in the Farlow Herbarium of Harvard University.

500–1000 μ long, 7–9 μ in diameter. Sporocladia stipitate, pleurogenous, distant, 10–12-septate, the basal cell rounded, the terminal cell sterile, slightly tapering and somewhat upcurved. Phialides in pairs on each segment of the sporocladium. Conidia fusoid, 8–9 μ long.

On the filaments of Mucorales and Saprolegniales. Belgium.

The above description is condensed from Coemans' original, and while not entirely satisfactory, it would be possible with the aid of the original drawings to determine the species should it be found again. So far as can be determined from reports in the literature, the species has not been discovered since it was originally described.

**3. Martensella Corticii** Thaxter sp. nov.

PLATES 3A; 4C.

Colonia effusa, stratum minutum et parcum efficiens, cremoricolora; conidiophoris simplicibus, hyalinis, 1–3-septatis, usque 200 μ longitudine, 5.5–6.5 μ diametro et sporocladia 1–3 gerentibus. Sporocladiis inflatis, (2)–3–4–(5)-septatis, 25–36 μ longitudine, 7–10 μ diametro, cellulis apicalibus sterilibus, sursum curvatis et leniter ad apicem fastigatis; vesiculis sporigeris 6–8 e superficie supera oriundis, 5–6 μ longitudine, 3.5 μ diametro; conidiis elongato-ellipsoideis vel subcylindraceis, leniter basem fastigatis et ad apicem rotundatis, 10.5–13 x 3.5–4.5 μ.

Colonies effuse, forming a minutely and sparsely hirsute layer over the substratum, pale yellowish or "Cream Color."[3] Conidiophores simple, hyaline, 1–3-septate, up to 200 μ long, 5.5–6.5 μ in diameter and bearing one or two, rarely three sporocladia. Sporocladia stipitate, the stalk cell 9–12.5 x 4.5 μ, the sporocladia (2)–3–4–(5)-septate, 25–36 μ long, inflated in the fertile portion where they are 7–10 μ in diameter, somewhat tapering to the bluntly rounded base and the sharply upturned sterile apex. Phialides 6–8 on the upper surface of the sporocladium, 5–6 x 3.5 μ. Conidia elongate-ellipsoid to subcylindrical, slightly tapering towards the base, rounded towards the apex, 10.5–13 x 3.5–4.5 μ.

Specimens examined: NEW BRUNSWICK, Campobello, on *Corticium* sp., *W. G. Farlow*, **type**; NEW YORK, Enfield Gorge near Ithaca, on *Corticium alutaceum*, Oct. 18, 1902, *G. W. Atkinson*.

Because of the fact that even from the very early stages the phialides are borne on the upper surface of the sporocladia, this species must be considered a member of the genus *Martensella* rather than of *Coemansia*. The species differs from *M. pectinata* by its much smaller dimension, by the fewer sporocladia that are produced, and by the fact that it grows, probably parasitically, on the basidiomycetous genus *Corticium*.

**COEMANSIA** Van Tieghem & Le Monnier, Ann. Sci. Nat. ser. V. **17**: 392–393, *pl. 25, figs. 136–139*. 1873.

The characters are those of the family except that the sporocladia are scattered along the upper part of the conidiophores and the phialides and

[3] Colors cited within quotation marks are those listed in Ridgway, R., Color Standards and Color Nomenclature. Washington, D. C. 1912.

conidia are produced from the lower surface of the sporocladia. Type species, *C. reversa* Van Tiegh. & Le Monn.

**4. Coemansia ceylonensis** Linder sp. nov.

PLATES 3C; 4A.

Colonia sparsa, albida vel pallide "Cream Color"; conidiophoris simplicibus, rectis, distanter septatis et sursum ubi sporocladia oriuntur nonnihil angulariter curvatis, 450 μ longitudine, 6–7.5 μ diametro; vesiculis sporigeris ellipsoideis, ad basem latam fastigatis, 5.5 x 2.5–3 μ; sporocladiis subsessilibus vel breve stipitatis, cellula stipitis 3.5–5.4 x 3.6 μ, sporocladiis 3–5-septatis, 23–29 x 5.5–7.5 μ, cellulis apicalibus brevibus, 4.5 x 2.5 μ et rectis vel nonnihil sursum recurvatis; conidiis pallide luteis, cylindraceis, ad basem fastigatis, ad apicem rotundatis, 11–13 x 2–2.5 μ.

Colonies white or pale "Cream Color," composed of scattered conidiophores. Conidiophores simple, erect, distantly septate below, more closely septate above, somewhat angularly bent where sporogenous branches arise, up to 450 μ long, 6–7.5 μ in diameter. Sporocladia subsessile or short-stipitate, the stalk cell 3.5–5.4 x 2.5–3 μ, the sporocladia 3–5-septate, 23–29 x 5.5–7.5 μ, the terminal cell short, 4.5 x 2.5 μ and tapering to a straight or recurved rounded apex. Phialides in pairs, ellipsoid or slightly tapering towards the relatively broad base, 5.5 x 2.5–3 μ. Conidia pale yellow, cylindrical tapering to the bluntly rounded base, rounded at the apex, 11–13 x 2–2.5 μ.

Specimen examined: INDIA, Ceylon, on straw in damp chamber, cultured by *R. Thaxter* (Acc. no. 6391), **type.**

This species is readily separable from others in the genus by the relatively short conidiophores and by the small number of subsessile, few-septate sporocladia that are produced.

**5. Coemansia spiralis** Eidam, Jahresber. schles. Ges. vaterland. Cult. **64:** 262–263. 1887.

*Martensella* (Coemansia) *spiralis* Bainier, Bull. Soc. Bot. France **26:** 245–246. 1879.

*Coemansia spiralis* (Bainier) Bainier, Bull. Soc. Myc. France **22:** 219–220. *pl. 14, figs. 6–8.* 1906.

PLATES 3E; 4H.

Conidiophores widely scattered, white to "Cream Color," simple or branching near the substratum, erect below, spirally twisted above, usually 500–1000 μ long (1–2 mm. according to Bainier), 10–13 μ in diameter, distantly septate. Sporogenous branches stipitate, the stipe cell 10–12 μ long, the sporocladia (5)–7–9-septate, 41–55 μ long, 5.5–9 μ in diameter, the sterile terminal cell straight or somewhat recurved, slightly tapering to the bluntly rounded apex. Phialides numerous on the lower surface of the sporocladi, elongate-ellipsoid to somewhat clavate. Conidia fusoid-cylindrical, hyaline or very dilutely colored, (16)–21–25 μ long, 1.5–2.5 μ in diameter.

Specimen examined: CONNECTICUT, West Haven, with *Saprolegnia* sp. on carcass of horse, Sept. 1888, Nov. 1888, *R. Thaxter* (Acc. nos. 6396, 6395).

Bainier first described this species as belonging in the section *Coemansia* of *Martensella* and eight years later Eidam, apparently independently, described *Coemansia spiralis* as a new species, giving *Coemansia* full generic standing and establishing the binomial. Some years later, however, Bainier, writing about *C. spiralis*, states that Eidam's species was the same as his and yet continued to use his own name as authority for the species. According to Article 58 of the International Rules of Botanical Nomenclature (1935), when Bainier transferred his species from *Martensella* to *Coemansia*, it immediately becomes a later homonym and is not valid. Accordingly, Eidam must be considered the author of the binomial. Although Bainier states that the two species, his and Eidam's, are the same, it should be noted that the measurements of the conidia of his species are given as 16 x 2.1 $\mu$, within the size range of Thaxter's specimens, yet Eidam states that the conidia measure 10–12 x 0.8–1 $\mu$, are sharply pointed and like crystals. There is therefore the possibility that the two authors had two different species, a point that can be clarified only by the examination of type specimens should they be available. For the time being, it seems best to take Bainier's statement at its face value.

**6. Coemansia reversa** Van Tieghem & Le Monnier, Ann. Sci. Nat. ser. V. **17**: 392–393. *pl. 25, figs. 136–139.* 1873; Bainier, Bull. Soc. Myc. France **22**: 218–219. *pl. 15, figs. 1–4.* 1906.

PLATES 1A; 4O.

Colonies bright yellow, "Baryta Yellow" to "Buff Yellow." Conidiophores up to 5 mm. long, 9–12 $\mu$ in diameter, ternately branched above, the branches all being fertile and bearing sporocladia. Sporocladia short-stipitate, the stipe 1-celled and 4.5–7.5 $\mu$ long, the sporocladia arcuate-recurved, 3–4–(5)-septate, 18–27 x 5.5–7.5 $\mu$, the apical cell sterile and of smaller diameter, with a bluntly rounded apex. Phialides numerous, ellipsoid, 4–4.5 x 2–2.3 $\mu$, sessile or constricted at the base, in diagonal rows of 2, 4 or rarely 5 across the lower surface of the sporocladium. Conidia yellow, broadly fusoid or with a rounded apex, (7.2)–9–(11) x 2–(2.5) $\mu$.

Specimens examined: MASSACHUSETTS, Cambridge, on *Isaria felina* on rat dung, Jan. 1899, *R. Thaxter* (Acc. no. 6397); Canton, on *Isaria felina* on rat dung, Nov. 29, 1933, *D. H. Linder;* FLORIDA, Silver Springs, on *Isaria* sp. on dung of wood rat, *R. Thaxter* (Acc. no. 2450); OHIO, on *Isaria* sp. on dung in laboratory culture, *R. Thaxter:* LOUISIANA. Baton Rouge, on *Isaria* on rat dung, Oct. 1942, *T. T. Ayers.*

Van Tieghem and Le Monnier described this fungus as growing on rat dung but it is likely that it actually was growing on *Isaria* as subsequently reported by Bainier (3) and as the above collections also indicate. If the species is confined to *Isaria,* then it shares with *Martensella Corticii* the distinction of being parasitic on one genus of fungi. Aside from its specialization, the species is well characterized by the ternately branched, rarely simple or furcate, conidiophores that bear arcuate-recurved sporocladia.

**7. Coemansia breviramosa** Linder sp. nov.

PLATE 4K.

Coloniae pallide luteae vel lucide "Maize Yellow"; conidiophoris sparsis, rectis, simplicibus, vel infra parce ramosis, sursum trifurcatis bifurcatisve, raro simplicibus, ramis brevibus, 1 mm. plus longitudine, 14.5–22 μ diametro; stipite sporocladii brevi, unicellulari, 2.5–7 x 5.4 μ; sporocladiis 7–9–(11)-septatis, 36–45–(48) x 8–9 μ, plerumque sursum curvatis et conidiophoris plus-minus parallelis; vesiculis sporigeris ellipsoideis, 5.4 x 2 μ; conidiis pallide luteis, acicularis, 18–20 x 1.5 μ.

The colonies pallid yellow to light "Maize Yellow." Conidiophores scattered, erect, simple or sparingly branched below, mostly trifurcate or bifurcate, less frequently simple above, somewhat angularly bent at the point of attachment of the sporocladia, 1 mm. or more in length, 14.5–22 μ in diameter near the base of the fertile portion. Stipe of the sporocladia short, 1-celled, 2.5–7 x 5.4 μ. Sporocladia 7–9–(11)-septate, 36–45–(48) x 8–9 μ, mostly upcurved and paralleling the conidiophore, the apical cell slightly recurved and tapering to a bluntly rounded apex. Phialides ellipsoidal and broadly attached at the base, 5.4 x 2 μ. Conidia pallid yellow or light cream color in mass, acicular, 18–20 x 1.5 μ.

Specimens examined: MASSACHUSETTS, Cambridge, on mouse dung, *R. Thaxter* (Acc. no. 6402); CONNECTICUT, New Haven, on mouse dung, Sept. 1890, *R. Thaxter* (Acc. no. 6400) **type**; New Haven, 1889–1890, *R. Thaxter* (Acc. no. 6410).

This species closely resembles *C. erecta* Bain. in its general habit and the type of branching of the fertile portion of the conidiophore. However, the very narrow spores, sharply pointed at both ends, serve to distinguish this species.

**8. Coemansia interrupta** Linder sp. nov.

PLATE 4L.

Coloniae pallide luteae, "Maize Yellow" vel "Baryta Yellow"; conidiophoris infra simplicibus, sursum simplicibus vel rare breve-furcatis, 500 μ plus longitudine, 9–14.4 μ diametro, sporocladia 8–15 acervatim gerentibus; stipite sporocladii 9–15 x 5.5–7.5 μ; sporocladiis (5)–7–8-septatis, 27–40 x 9 μ, saepe cellula basali sporocladii angulariter sursum curvata ut sporocladia appareant plus minusve parallela cum conidiophoris, cellula ultima sterilia recurvataque; vesiculis sporigeris ovoideis vel elongato-ellipsoideis, 5.5–7 x 3.5 μ; conidiis luteis, anguste fusoideis vel subcylindraceis, 12.5–14.5–(18) x 2.5 μ.

Colonies pale yellow or "Maize Yellow" to "Baryta Yellow." Conidiophores simple or occasionally short-furcate above, 500 μ or more long, 9–14.4 μ in diameter, bearing the sporocladia pleurogenously and close together in clusters of 8–15, often continuing to grow and to produce after a brief interval, additional clusters of sporocladia. Stipe of sporocladia 1-celled, 9–15 x 5.5–7.5 μ. Sporocladia (5)–7–8-septate, 27–40 x 9 μ, the basal cell angularly upturned so that the sporocladia approximately parallel the main axis of the conidiophore, the terminal cell and occasionally the subterminal cell sterile and recurved. Phialides ovoid or elongate ellipsoid with broad basal attachment, 5.5–7 x 3.5 μ.

Conidia yellow in mass, narrow-fusoid or subcylindrical, 12.5–14.5–(18) x 2.5 $\mu$.

Specimen examined: without locality, on dung in culture, *R. Thaxter* (Acc. no. 6408), **type.**

This species closely resembles the preceding excepting that the sporocladia tend to occur in clusters and to be less frequently septate, and the conidia are somewhat shorter and stouter and not so sharply pointed at the ends.

**9. Coemansia erecta** Bainier, Bull. Soc. Myc. France **22:** 220–221. *pl. 14, figs. 9–12.* 1906.

PLATES 2A, C; 3B; 4C.

Colonies pallid yellow to bright yellow or "Baryta Yellow." Conidiophores simple, bifurcate or trifurcate in the upper fertile zone, or occasionally ascending-branched below, distantly septate, up to 2–4 mm. long, 7.2–14 $\mu$ in diameter. Sporocladial stipe 1-celled, 3.5–7.2 $\mu$ long. Sporocladia curved upward at the basal cell at an acute angle from the conidiophores, 5–8-septate, 20–36 x 5.5–6.5 $\mu$, the terminal cell and rarely the subterminal cell sterile and somewhat tapered to the rounded apex. Phialides ovoid, 3.5–6 $\mu$ long. Conidia 6.5–9–(11) x 1.5–2.5 $\mu$, rounded tapering to the slender truncate point of attachment, rounded at the apex.

Specimens examined: CONNECTICUT, New Haven, on mouse dung, 1889 and Sept. 1890, *R. Thaxter* (Acc. nos. 6407, 6403); FLORIDA, on bat dung in culture, *R. Thaxter* (Acc. nos. 6401, 6405, 6409); JAMAICA, B. W. I., on dung, *R. Thaxter* cult. (Acc. no. 2677).

This species appears, on the basis of the few specimens available for study, to be the most variable. The conidiophores are either simple or forked or else ternately branched, and according to length of the branches, the species takes on quite different aspects. In the older specimens the differences in appearance are emphasized by the fact that after the first group of sporocladia have lost their conidia, the conidiophores continue to grow and after an interval to produce additional sporocladia and often at the same time to become procumbent. In spite of this variation, however, the species may be recognized by the morphology of the sporocladia and by the shape and small size of the conidia. The American specimens appear to produce smaller conidia than do the European since the size ranges from 7–9 $\mu$ with but a few that are 10 $\mu$ long, whereas Bainier states that the spores of the type measure 11.2 x 2.8 $\mu$, a difference that would appear to be insignificant.

**10. Coemansia kamerunensis** Thaxter sp. nov.

PLATES 1B-C; 4F. . .

Coloniae "Cream Colored"; conidiophoris hyalinis, rectis, repetito furcatis, leviter ad basem stipitis sporocladii angulatis, 1 mm. plus altitudine, 12.5–16.5 $\mu$ diametro; stipitibus sporocladiorum e conidiophoro angulariter sursum oriundis, unicellulatis,

7.2–11 x 5.4 μ; sporocladiis (6)–8–9-septatis, 32.5–41.5 x 7.2–9 μ, cellula basali angulariter sursum curvata et cellula sterilis apicali nonnihil recurvata leniterque ad apicem rotundatum attenuata; vesiculis sporigeris ellipsoideis, elongato-ellipsoideis vel late fusoideis, 5–7 x 2–2.5 μ, binis vel rariter ternis; conidiis fusoideis, ad basem tenuem attenuatis, ad apicem rotundatis, 11.5–14.5 x 1.5–2 μ.

Colonies "Cream Colored." Conidiophores hyaline, erect, repeatedly and occasionally dichotomously forked, slightly angularly bent at the point of attachment of the sporocladial stipe, 1 mm. or more long, 12.5–16.5 μ in diameter at the base of the fertile portion. Sporocladial stipe arising at an acute angle from the conidiophore, 1-celled, 7.2–11 x 5.4 μ. Sporocladia (6)–8–9-septate, 32.5–41.5 x 7.2–9 μ, the basal cell angularly bent upwards so that the sporocladium nearly parallels the main axis of the conidiophore, the sterile apical cell roughened, slightly recurved and somewhat tapering to a bluntly rounded apex. Phialides ellipsoid to elongate ellipsoid or broadly fusoid, 5–7 x 2–2.5 μ, in pairs or threes. Conidia fusoid, tapering towards the slender truncate base, rounded at the apex, 11.5–14.5 x 1.5–2 μ.

Specimens examined: CAMEROONS, W. AFRICA, cultured on dung sent by Geo. Schwab by *R. Thaxter* (Acc. no. 6392), **type**, and (Acc. no. 5372).

This species is very closely akin to *C. guatemalensis* if the morphology and dimensions of the conidia may be considered as reliable criteria. It is, however, distinguished by the more robust and the repeatedly forked conidiophores.

**11. Coemansia braziliensis** Thaxter sp. nov.

PLATES 2D; 4M-N.

Coloniae luteae vel siccatae "Cream Buff"; conidiophoris rectis, infra simplicibus supra in partibus fertilibus furcatis vel rare trifurcatis, rarissime simplicibus, 2 mm. plus longitudine, usque 25 μ diametro, leniter infra attenuatis, distanter septatis; stipite sporocladii unicellulari, brevi, latitudo prope ad longitudinem accedit; sporocladiis 8–12-septatis, 30.5–36 x 6.3–7.2–(9) μ, fortiter arcuate vel nonnihil spiraliter sursum curvatis, cellula sterilis ultima elongata et frequenter fastigata recurvataque; cellulis sporigeris ovoideis vel ellipsoideis, 3.5–5.5 x 2 μ; conidiis in acervo luteis, fusoideis, ad basem tenuiter truncatam et ad apicem obtuse rotundatum fastigatis, 11–14.5 x 2–2.5 μ.

Colonies bright yellow or "Cream Buff" on drying. Conidiophores erect, simple below, furcate above in the sporocladial zone, rarely trifurcate and very rarely unbranched, 2 mm. or more long, up to 25 μ in diameter and tapering to the base, slightly tapering upwards to 14.5–18 μ at the point where the conidiophores are forked, septations distant. Sporocladial stipe 1-celled, approximately as broad as long. Sporocladia 8–12-septate, 30.5–36 x 6.3–7.2–(9) μ, strongly arcuately or somewhat spirally upturned, the terminal cell elongate, often recurved and tapering to a rounded apex. Phialides ovoid or ellipsoid, 3.5–5.5 x 2 μ. Conidia yellow in mass, fusoid, tapering towards the slender truncate base and towards the bluntly rounded apex, 11–14.5 x 2–2.5 μ.

Specimens examined: without locality, on Brazil nuts (*Bertholletia excelsa*) in laboratory culture, *R. Thaxter* (Acc. no. 6398), **type.**

The fan-like appearance of the sporocladia with their spores, distinguish this beautiful species rather readily, and the differences are further enhanced by the morphology and dimensions of the conidia. A further aid in separating this from the related *C. erecta* is furnished by the greatly elongated branches that result from the forking of the conidiophore.

**12. Coemansia guatemalensis** Thaxter sp. nov.

PLATES 3F; 4D.

Coloniae flavae vel exsiccatae "Mustard Yellow"; conidiophoris simplicibus vel interdum furcatis et ramis imparibus, 1 mm. plus longitudine, 9–11 μ diametro; stipitibus sporocladiorum e conidiophoro angulariter sursum oriundis, unicellulatis, 5.5–11 x 3.5–5.5 μ; sporocladiis 6–7-septatis, 26–33.5 x 6.5–7.5 μ, cellula basali angulariter sursum curvata et cellula sterilis apicali plerumque rectis et nonnihil ad apicem rotundatum attenuata; vesiculis sporigeris ellipsoideis vel elongato ellipsoideis, 3–5 x 2–2.5 μ; conidiis luteis sub microscopico, fusoideis, ad basem tenuem rotundato-attenuatis, ad apicem rotundatis, 12.5–14.5 x 1.5–2.5 μ.

Colonies golden yellow or on drying becoming "Mustard Yellow." Conidiophores 1 mm. or more long, 9–11 in diameter, simple or occasionally forked above with the resulting branches of unequal length. Sporocladial stipe one-celled, arising at an acute angle from the axis of the conidiophore, 5.5–11 x 3.5–5.5 μ. Sporocladia sharply upturned at the basal cell and nearly paralleling the conidiophores, the apical cell sterile, longer than broad and somewhat tapering to the rounded tip, 6–7-septate, 26–33.5 x 6.5–7.5 μ. Phialides numerous, ellipsoid to elongate-ellipsoid, 3–5 x 2–2.5 μ. Conidia yellowish under the microscope, fusoid, rounded tapering to the slender basal apiculus, rounded at the apex, 12.5–14.5 x 1.5–2.5 μ.

Specimens examined: GUATEMALA, Los Amates, on pig dung sent by W. A. Kellerman and placed in moist chamber, 1908, *R. Thaxter* (Acc. no. 6389). **type;** El Rancho, data otherwise as in preceding (Acc. no. 6390).

As has been mentioned above, this species resembles *C. kamerunensis*, in the discussion of which the distinguishing characteristics have been pointed out. *C. guatemalensis* may be confused with the simple, unbranched stages of *C. erecta* which, however, is predominantly ternately branched and only rarely simple. Furthermore, the length of the spores of the latter species is from 6.5 to 9, rarely 11 μ.

**13. Coemansia aciculifera** Linder sp. nov.

PLATE 4I-J.

Coloniae luteae vel siccatae "Buff Yellow"; conidiophoris simplicibus vel irregulariter ramosis, non furcatis, 1 cm. longitudine plusve, 9–11 μ diametro, distanter septatis, sursum nonnihil tortuosis ubi stipites sporocladiorum adjuncti sunt; stipitibus sporocladiorum 1–2 cellulatis, 21–40 x 5.5–7.5 μ, vetioribus frequenter proliferantibus et producentibus stipitem sporocladiaque secundaria vel interdum elongatis in

ramum brevem; sporocladiis (7)–8–(10)-septatis, 36–45 x 9–11 μ, cellula terminali sterili, attenuata, fortiter recurvata rostrataque; vesiculis sporigeris ovoideis, binis, 5–5.5 x 2 μ; conidiis acervatis dilute flavis, sub microscopico acicularibus, 14.4–18 x 1.5 μ; mycelio gangliiformiter incrassatis.

Colonies bright yellow or "Buff Yellow" on drying. Conidiophores erect, simple or irregularly branched below, not furcate or ternate, up to 1 cm. or more long, 9–11 μ in diameter, distantly septate, the upper fertile part angled at the point of attachment of the sporocladia and becoming somewhat zig-zag. Stipe of sporocladia 1–2-celled, 21.5–40 x 5.5–7.5 μ, the older ones tending to proliferate and to produce an additional stipe and sporocladium or else a short branch. Sporocladia (7)–8–(10)-septate, 36–45 x 9–11 μ, the terminal cell sterile, tapering, sharply recurved and beak-like. Phialides ovoid, in pairs, 5–5.5 x 2 μ. Conidia light yellow in mass, acicular, 14.4–18 x 1.5 μ.

Specimen examined: MAINE, Kittery Point, cultured from zygospores in *Sphagnum*, *R. Thaxter* (Acc. no. 6404), **type.**

This species because of the relatively simple conidiophores bearing distantly spaced sporocladia and because of the elongate spores, strongly resembles *C. Thaxteri* and *C. pectinata.* From both of these species it differs by the elongate, very slender and somewhat curved conidia that are sharply pointed at either end, whereas in the two mentioned species, the apical ends of the conidia are rounded. Another character which separates this from all other species in the genus is to be found in the gangliform swellings of the vegetative mycelium which, as has already been pointed out, are similar to the swellings in the mycelium *Mortierella tuberosa* and related species. It would be of interest to know if these swellings are somehow correlated with homothallism since in a slide made by Thaxter, not only are these swellings present but so also are young zygospores. Unfortunately, it is impossible to determine from the slide whether the gametes arose from branches of mycelium from the same thallis or from two different thalli. From the taxonomic point of view, however, it is important that Thaxter was able to grow the fungus from mature zygospore to immature zygospore (pl. 4, fig. 1) and thus to refute Saccardo and others who saw in the genus only hyphomycetous species that were possibly the conidial stage of a pyrenomycete. By thus growing the fungus from resting spore to immature resting spore, he was able to demonstrate the phycomycetous affinity of this and related genera.

**14. Coemansia scorpioidea** Linder sp. nov.

PLATES 3D; 4B.

Coloniae albidae vel "Cream Color," sparsae; conidiophoris simplicibus, hyalinis, rectis, distanter septatis, usque 2 mm. longitudine, 7–9 μ diametro, (1)–5 ramos sporigeros scorpioide gerentibus; stipite sporocladii 0–2-septato, 18–27 x 4.5–7.5 μ; sporocladiis 5–6–(7)-septatis, 22–32.5 x 5.5–7.5 μ, cellula terminali vel interdum subterminali sterili et ad apicem fortiter usque 2 μ attenuata; vesiculis sporigeris

ovoideis ad basem fastigatis, binis, 5–6 x 2.5–3 μ.; conidiis elongatis, acicularis inaequilateralisque, e medio ad extremos acutos attenuatis, 16–18–(23.5) x 2 μ.

Colonies whitish to "Cream Color," composed of few scattered conidiophores. Conidiophores simple, erect, distantly septate, up to 2 mm. long, 7–9 μ in diameter, bearing (1)–5 sporocladia in a scorpioid manner. Stipe of sporocladium 1–2-septate, 18–27 x 4.5–7.5 μ. Sporocladia 5–6–(7)-septate, 22–32.5 x 5.5–7.5 μ, the terminal and occasionally the subterminal cells sterile with the apex of the terminal cell or the whole terminal cell sharply reduced in diameter to approximately 2 μ. Phialides ovoid, somewhat tapering towards the base, 5–6 x 2.5–3 μ, usually arranged in pairs. Conidia elongate, acicular, inequilateral, tapering from the middle towards the sharply pointed ends, 16–18–(23.5) x 2 μ.

Specimen examined: NEW HAMPSHIRE, Alstead, on duck dung in laboratory culture, Mar. 1918, *R. Thaxter* (Acc. no. 6394), **type.**

This species is immediately characterized by the scorpioid arrangement of the few, long-stipitate sporocladia, and by the long, slender, sharply pointed conidia that are inequilateral and nearly straight or slightly concave on one side.

**15. Coemansia Thaxteri** Linder sp. nov.

PLATES 1D; 4E.

Conidiophoris erectis, simplicibus vel rarissime infra ramosis, 1 cm. plus longitudine, 12.5–15 μ diametro, cellulis superioribus quibusque unum sporocladium gerentibus; stipitibus sporocladiorum elongatis 0–2-septatis, cellulis (25)–36–54 x 5.5–7.5 μ metientibus; sporocladiis (6)–7–(10)-septatis, (32.5)–50–63 x 9 μ, cellula terminali sterili brevi, nonnihil recurvata et ad apicem rotundatum attenuata; vesiculis sporigeris numerosis, ellipsoideis, 4.5–5.5 x 2–3 μ.; conidiis cylindraceis, angustatis, ad basem tenuem attenuatis et ad apicem rotundatis (18)–21–23.5–(25) x 1.5–2 μ.

Conidiophores erect, simple or very rarely branched below, 1 cm. or more long, 12.5–15 μ in diameter, the upper cells elongate and each bearing one sporocladium. Sporocladial stipe elongate and composed of one to two cells which together measure (25) 36–54 x 5.5–7.5 μ. Sporocladia (6)–7–(10)-septate, (32.5)–50–63 x 9 μ, the sterile terminal cell short, somewhat recurved and tapering to a rounded apex. Phialides numerous and in diagonal rows of 2–5 across the lower surface of the fertile sporocladial cells, ellipsoid, 4.5–5.5 x 2–3 μ. Conidia cylindrical, narrow, tapering towards the slender truncate base and rounded at the apex, (18)–21–23.5–(25) x 1.5–2 μ.

Specimen examined: MASSACHUSETTS, Cambridge, on dead coleopterous larvae in moist chamber, 1896–'97, *R. Thaxter* (slide), **type.**

*C. Thaxteri* is by far the largest species of the genus, not only in respect to the size of the conidia, but also as to the size of the conidiophores. The differences between this and the two related species, *C. aciculifera* and *C. pectinata* have been discussed under the former species.

It is indeed a great pleasure to dedicate this handsome species to the

memory of Professor Roland Thaxter as a token not only of the debt owed him for assembling the excellent collection which it has been the writer's privilege to study in preparing this paper, but also as an acknowledgement of his extensive knowledge of this and related groups of fungi.

**16. Coemansia pectinata** Bainier, Bull. Soc. Myc. France **22**: 216–218. *pl. 14, fig. 2–5.* 1906.

Conidiophores erect, simple, distantly septate, over 500 μ long, 9.8 μ in diameter. Sporocladial stipe distantly spaced (112–140 μ apart) on and arising nearly at right angles to the conidiophore, mostly 1-celled, 20–28 μ long, occasionally branching and bearing 2–5 sporocladia. Sporocladia 8–10-septate, up to 39 μ long, sharply curved-ascending at the basal cell and nearly parallel to the conidiophore, the sterile apical cell somewhat recurved and tapering to the bluntly rounded tip. Phialides in pairs, cylindrical (?), 4.2 x 2.8 μ. Conidia fusiform, 14 x 2.8 μ, tapering towards the rounded ends.

On horse dung, Paris, France.

The above description is translated and condensed from the original. In the account, Bainier did not appear at all certain that this species was not the same as *Martensella pectinata* and implied that the latter was poorly described by Coemans. By placing the latter binomial in italics under his species, he inferred that it was, contrary to the principles of priority, a synonym. However, Bainier did point out the discrepancies between his species and Coemans' and by so doing, it is possible to recognize it as valid and distinct. However, the lax application of rules of nomenclature made possible the confusion that has resulted concerning the status of the genera *Martensella* and *Coemansia.*

## EXCLUDED SPECIES.

**Coemansia repens** Therry, Rev. Myc. **5**: 45. 1883.

This is a *nomen nudum*, the species being mentioned only as a new species in the report on a foray.

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## EXPLANATION OF PLATE 1

All drawings were made with the aid of a camera lucida. Each unit of the scale equals 10 μ.

A. *Coemansia reversa* Van Tieghem & Le Monnier. Habit drawing to show the ternately forked conidiophore with the characteristically recurved sporocladia that are for the most part immature.

B-C. *Coemansia kamerunensis* Thaxter. In figure B is shown the upper portion of a repeatedly forked conidiophore and in figure C the interrupted production of sporocladia on a simple conidiophore.

D. *Coemansia Thaxteri* Linder. The upper fertile portion of the very elongate conidiophore with each cell bearing a single long-stipitate sporocladium. This distribution of the sporocladia is equally characteristic of *C. pectinata* and *C. aciculifera*.

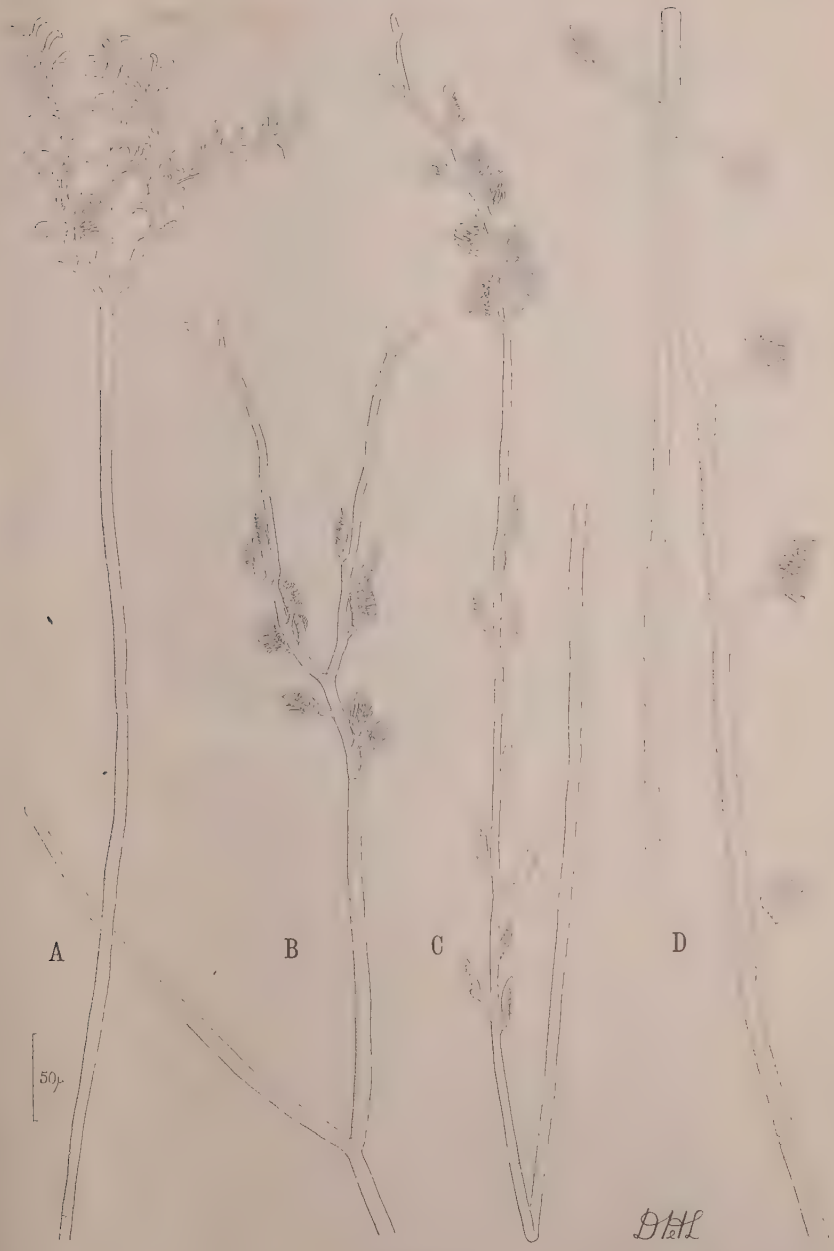


PLATE 1.

## EXPLANATION OF PLATE 2

All drawings were made with the aid of a camera lucida. Each unit of the scale equals 10 μ.

A, C. *Coemansia erecta* Bainier. In figure A is depicted the furcate fertile portion of the conidiophore characteristic of the species when it is growing vigorously, while in figure C is shown a conidiophore from an old culture in which the fungus has tended to become more or less repent and to produce the sporocladia in an irregular manner.

B. *Kickxella alabastrina* Coemans. The conidiophores of this species are at first simple but later become cymosely branched. The sporocladia are produced in a whorl on the slightly globose-swollen apex of the conidiophore. The sporocladia usually terminate in branched sterile cells although not infrequently these cells may be simple.

D. *Coemansia braziliensis* Thaxter. This species is characterized by the usually furcate, rarely simple, conidiophores and the sharply upcurved and somewhat spirally twisted sporocladia which have a fan-like appearance.

PLATE 2.

## EXPLANATION OF PLATE 3

All drawings are made with the aid of a camera lucida. Each unit of the scale equals 10 μ.

A. *Martensella Corticii* Thaxter. This species is set apart from others by the short conidiophores that are produced on the surface of *Corticium* spp., and by the fact that the phialides are produced on the upper surface of the sporocladia.

B. *Coemansia erecta* Bainier. The conidiophore illustrated here is rather atypical since it is branched below the fertile zone and the sporocladia are somewhat more closely aggregated than is usual. A typical conidiophore is shown in Plate 2 A.

C. *Coemansia ceylonensis* Linder. This species, the smallest of the genus, is also characterized by the small number of few-septate sporocladia.

D. *Coemansia scorpioidea* Linder. This species is readily distinguished by the scorpioid arrangement of the sporocladia at the apex of the conidiophore as well as by the elongate, 1–2 celled sporocladial stipes.

E. *Coemansia spiralis* Eidam, showing the spirally twisted upper end of the conidiophore.

F. *Coemansia guatemalensis* Thaxter. The slender conidiophores bearing the sporocladial stipes at nearly right angles to the main axis, the sharply upcurved basal cell of the sporocladium, and the dimensions of the spores all help to separate this from other species of *Coemansia*.

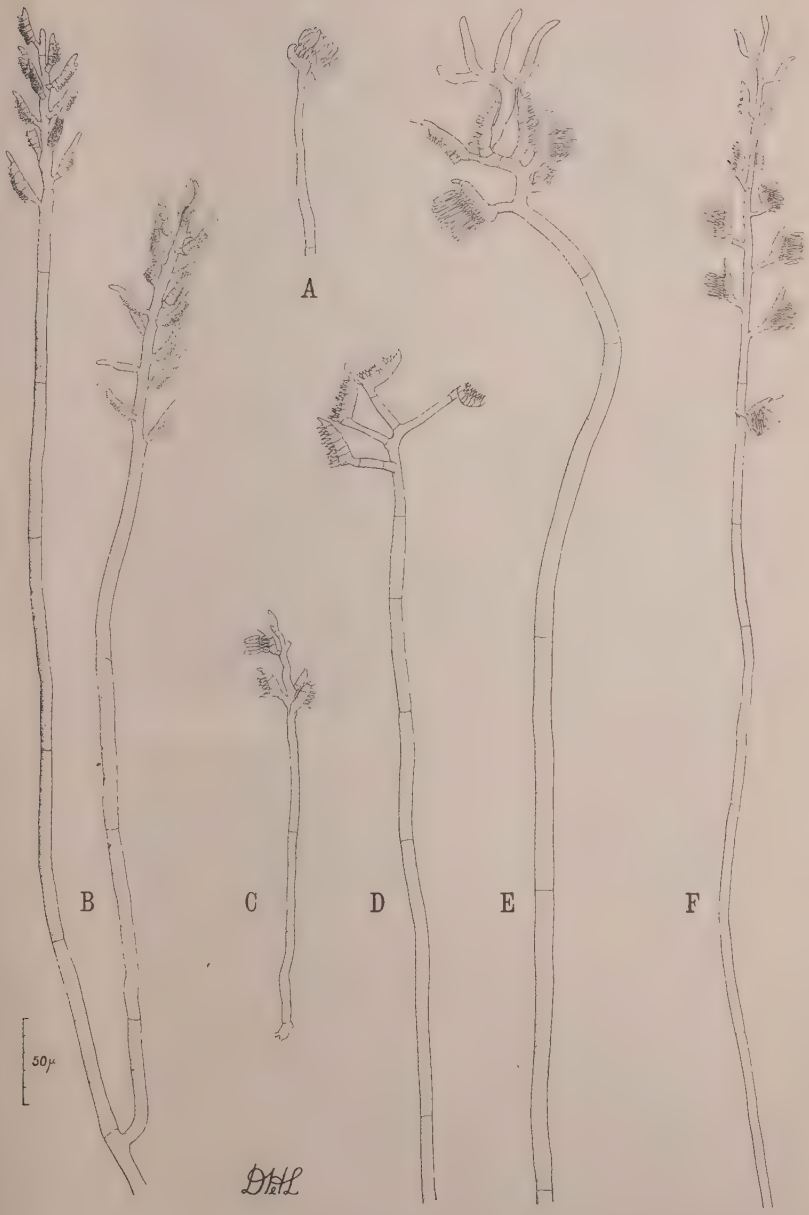


PLATE 3.

## EXPLANATION OF PLATE 4

All drawings were made with the aid of a camera lucida. Each unit of the scale equals 10 μ.

A. *Coemansia ceylonensis* Linder.

B. *Coemansia scorpioidea* Linder. A sporocladium from which most all spores have fallen.

C. *Coemansia erecta* Bainier.

D. *Coemansia guatemalensis* Thaxter.

E. *Coemansia Thaxteri* Linder.

F. *Coemansia kamerunensis* Thaxter.

G. *Martensella Corticii* Thaxter. Immature sporocladia.

H. *Coemansia spiralis* Eidam. An immature sporocladium showing the phialides which are at first cylindrical.

I-J. *Coemansia aciculifera* Linder. Immature zygospore from sphagnum is shown in figure I, while a discharged sporocladium and a single conidium, pointed at both ends is illustrated in figure J.

K. *Coemansia breviramosa* Linder. An immature sporocladium, and three conidia.

L. *Coemansia interrupta* Linder. A mature, discharged sporocladium and 2 conidia.

M-N. *Coemansia braziliensis* Thaxter. A mature sporocladium with spores (M) and immature sporocladia (N).

O. *Coemansia reversa* Van Tieghem & Le Monnier, showing sporocladia in different early stages of development.

P. *Kickxella alabastrina* Coemans. A single sporocladium at an early stage of development in which the phialides have produced sterigmata on which conidia will be produced. Above the sporocladium are shown two conidia, of which the left hand one has been drawn in optical section to demonstrate the annular ring that has been laid down inside the conidial wall.

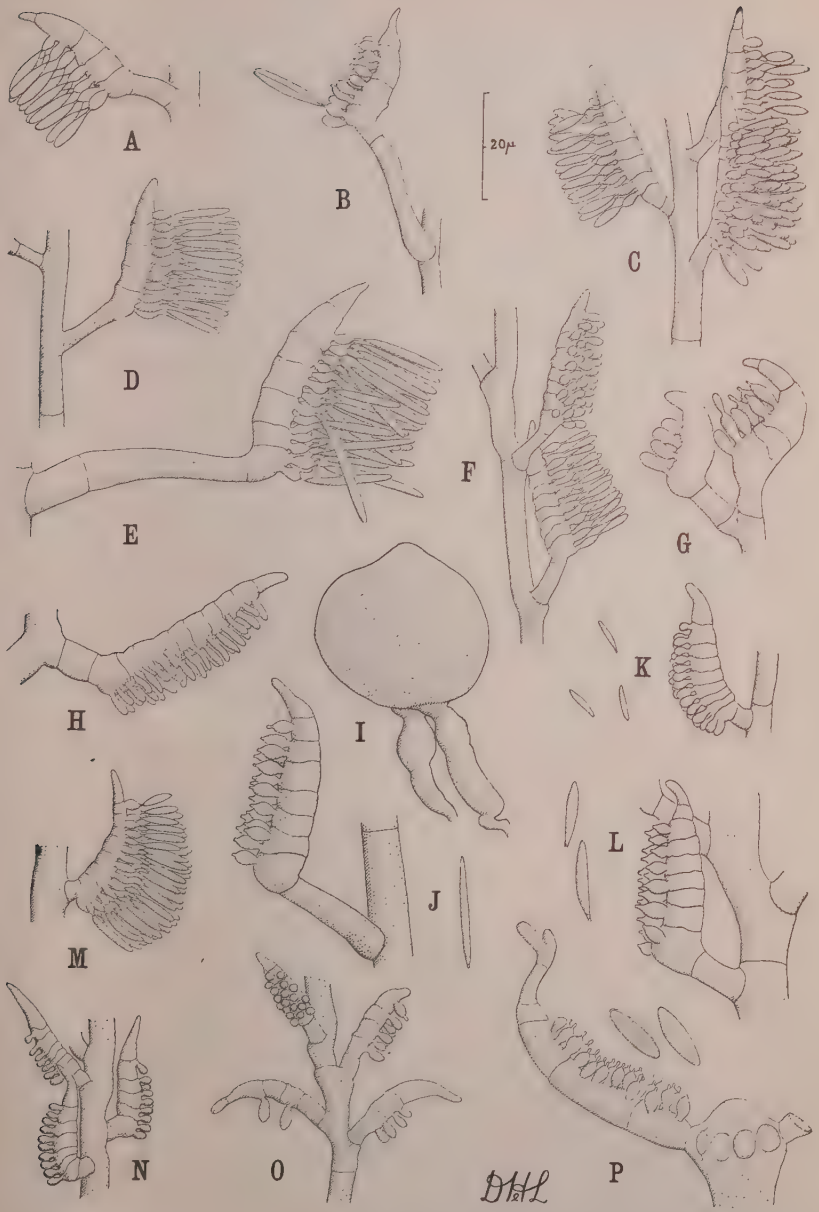


PLATE 4.

1(1): 79–93 FARLOWIA January, 1943

# BASIDIUM FORMATION AND SPORE DISCHARGE IN GYMNOSPORANGIUM NIDUS-AVIS [1]

ALTON E. PRINCE [2]

During the course of life history studies of *Gymnosporangium nidus-avis*, an extensive investigation was conducted on the process of teliospore germination from basidium formation to discharge of the basidiospores. For the necessary observations a special technique, described below, had to be perfected. The general method employed for observing the various stages of germination under the oil immersion lens is not new, but apparently the adaptation devised here has not been employed previously for this purpose. Shallow Van Tieghem cells 4 to 5 mm. high were used to reduce the difficulties ordinarily encountered when attempting to obtain proper light. A small, moist mass of teliospores was placed on a thin cover glass and spread out as much as possible; then another cover slip, small enough to go inside of the cell was pressed onto the telial mass, and the whole then inverted over the cell which contained a small drop of distilled water. The glass slip served five purposes: (1) It permitted the use of any number of mounts which could be kept under ordinary laboratory conditions. (2) No regulation of the temperature was necessary to prevent the water from condensing on the under side of the cover glass. (3) The water of condensation formed on the under side of the glass slip where it did not interfere with the germination of the spores nor with the observations. (4) The teliospores were kept in a thin layer under conditions of high humidity where they could germinate and produce basidiospores normally and where they could be observed readily under the oil immersion lens. (5) The difficulty described by Buller (1924, p. 524) of getting the teliospores to germinate and produce basidiospores normally was thus overcome.

The mode of teliospore germination in *G. nidus-avis* does not differ from other pucciniaceous rusts that have been investigated by various workers. However, since it is believed that a more detailed study has been made than previously, the facts found will be presented. In this discussion the terminology of Linder (1940) has been adopted.

As Farlow (1880) and Thaxter (1891) reported, the thin-walled teliospores may germinate at both ends after becoming separated from their pedicels. When this takes place, the basidium of the lower cell passes through the locus where the passage from the pedicel into the spore had been during the growing period of the spore. Usually only one basidium

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, No. 217.

[2] It is with pleasure that the author acknowledges the guidance and constructive criticism of Dr. D. H. Linder and Dr. J. H. Faull during the entire progress of this investigation and to Dr. W. H. Weston, Jr., for suggestions and criticism concerning this manuscript.

is produced by each cell of a spore, but occasionally more may start to form. However, only one develops completely.

There are two types of basidia formed when teliospores germinate, depending upon the environmental conditions. The first type of basidium, which is considered normal, is characteristically formed by teliospores which are near the surface of the telium. In these, the basidia are variable in length, uniform in diameter, sessile (Pl. 1, B), and subsequently become divided into four cells, each cell of which normally gives rise to a sterigma bearing a basidiospore. Occasionally normal basidia are produced by spores deeply embedded in the telium, but when this occurs the four cells of the basidium become separated at their septa, a phenomenon often described by other investigators. The individual cells, when allowed to germinate in water, instead of producing basidiospores, proceed to germinate by germ tubes which are capable of penetrating the host and causing infection. This, however, would rarely if ever occur except in artificial inoculations since the individual cells could not be dislodged from the gelatinous matrix of the telium. Therefore, it can be concluded that basidiospores in nature constitute the only structure for the dissemination of the rust from its telial hosts.

The second type of basidium is produced from teliospores deeply embedded in the telial matrix when, as noted by Linder (1940), there is formed a basidial stipe, that is a fifth cell of the basidium, and which may be 100 $\mu$ or longer, the length depending upon the distance of the teliospore from the air. The diameter of the stipe is usually about one-third of that of the spore-bearing portion of the basidium, or if the stipe is short it may be of the same diameter as the basidium. When teliospores are deeply embedded, the basidial stipe enlarges only as it approaches the surface or after it is out of the telial matrix (Pl. 1, A), but even after this the spore-producing portion of the basidium may sometimes become covered with water, after which the sterigmata usually grow long enough to form their spores in the air.

During the active period of germination, the young basidium has a colorless thin wall and is filled with a yellowish-orange protoplasm. When a basidial stipe is produced, its appearance at first is very much like that of a non-septate vegetative hypha and as the stipe elongates only the outer portion remains filled with the colored protoplasm. The portion next to the teliospore becomes hyaline, vacuolate, with occasional globules of the yellowish-orange cell contents. Finally, when the basidial stipe reaches the surface of the matrix, the enlarged portion of the basidium is formed (Pl. 1, A), after which most of the colored protoplasm passes into the outer enlarged portion and is then cut off by a septum at its base. The basidial stipe remains turgid to the extent that it may support the whole enlarged end until after the basidiospores have been discharged. From this stage the formation of sterigmata and basidiospores is the same as when there is no basidial stipe. A wall

first divides the basidium into two nearly equal parts and then the two halves are likewise divided by a septum in each, resulting in the formation of the four basidial cells. A sterigma soon begins to form on one of the cells or more than one sterigma may be produced simultaneously on two or more cells, but there is no definite order for their formation. Once a basidium becomes divided into its constituent parts, each segment appears to be a separate unit more or less independent of the other cells of the basidium.

The presence of a continuous wall around the basidium permits a comparison of a basidium with a four-spored ascus, the outer continuous wall being comparable to the wall of an ascus and the four cells, each with its wall, to the ascospores. The correlation of this fact with the cytological findings of Olive (1942) who established the presence of astral rays during nuclear divisions in *Coleosporium* is additional evidence for the theory proposed by Linder (1940) that rusts originated from an ascomycetous ancestor.

The sterigma starts as a protuberance from the surface of a basidial cell (Pl. 1, B). Usually all four sterigmata arise from the same side of the basidium, but the forms of the sterigmata are variable and may be long or short as shown in Pl. 1, G and K, respectively. Long sterigmata are often twisted or variously contorted. By the time a sterigma has attained its maximum length which may be 50 $\mu$ or more, depending upon the distance of the basidium from the air, the sterigma has a more or less tapered distal end from which a basidiospore begins to form almost immediately. The spore at first appears as a globose enlargement of the apex (Pl. 1, C), then it grows more on one side and becomes sub-ovoid (Pl. 1, D-E) and subsequently the growth rate of the spore is increased greatly. During this period the yellow-orange cytoplasm can be seen rushing from the basidial cell through the sterigma and into the spore where there is a microscopic maelstrom of whirling cytoplasm. The flow of the colored protoplasm into the rapidly forming spore is restricted to a central channel in the sterigma (Pl. 1, E), there being little or no movement of the hyaline, parietal protoplasm. The opening from the sterigma into the basidiospore being approximately 1.5 $\mu$ in diameter is large enough to permit the rapid passage of the cell content. However, during the course of the migration of the cell content, it was observed occasionally that the flowing might cease for an instant, then a reverse flow take place, and after a moment, the outward flowing into the spore is resumed.

The spore continues its growth until all, or nearly all, of the colored protoplasm has passed from the basidial cell into the spore (Pl. 1, F and L), and by that time the spore has reached its maximum size. Very soon afterwards a septum (Pl. 1, G-H) is formed a short distance below the spore in the sterigma, thus forming the apiculus, and following this the basidial cell and the sterigma remain turgid and filled with the

hyaline, vacuolate periplasm, some of which soon appears to become much concentrated in the apex of the sterigma (Pl. 1, K). At the same time similar appearing material which can be differentiated from the yellowish and more dense content of the spore, can be seen in the newly formed apiculus (Pl. 1, H).

The nature of the hyaline material is unknown, but that it plays an important part in the discharge of the spore is almost certain. It is more than possible that this substance is like the periplasm found in the ascus where it is known to have a marked affinity for water, and in this way a pressure is built up, thus bringing about the discharge of the ascospores. This hyaline material may have a similar function in the sterigmata and apiculi of the basidiospores of *Gymnosporangium nidus-avis*, that is, it may take on water with the production of a pressure in both of these extremities and result in the violent discharge of the basidiospores. That the material may act as a plug to prevent the collapse of the sterigmata and spores after the discharge is not probable because there is a definite wall over the apices of both the sterigmata and the apiculi and therefore no plug is necessary. The septum between the spore and sterigma has a middle lamella and as soon as the septum is formed the spore seems to pass through a very brief maturation period which may have a duration of a few seconds to a few minutes. About ten to twenty seconds before the spore is discharged there is produced, just above the apiculus, on the flattened edge of the spore, a droplet (Pl. 1, I-J) that appears to come from a hilum of some kind, but a diligent search has failed to reveal any opening. However, at the place where usually one large drop is given off, but where sometimes several small ones are emitted and nearly always, whether it is only one or whether there are several, they are usually given off from a fraction to about ten seconds before the spore is discharged. The droplets were seen a few times to flow down the sterigma prior to discharge of the spore, a fact reported previously by Buller (1922) as occurring in abnormal cases, and in addition the single drops occasionally are carried away on their spores. After the droplets have been produced, and at the moment before discharge, the spores vibrate as if under tension, but after the discharge a definite wall is evident over the end of the sterigma and over the end of the apiculus (Pl. 1, M, a), both the walls being a little less than a micron thick, are distinctly convex showing that they are under pressure, but the apiculus soon nearly disappears whereas the apex of the sterigma remains rounded until the basidial cell bearing it subsequently collapses.

The actual discharge occurs so quickly it is not possible to see exactly what happens, but from observations and photographs (Pl. 1) made just before and after the discharge, and from the study of germinated teliospores which have been fixed in 4% formalin and stained in 0.1% aqueous cotton blue it is possible to offer a theory that seems to be a plausible explanation of this phenomenon. In a consideration of

this theory, it will be recalled from the preceding description that at the earliest stage in the formation of the basidiospore, the apex of the sterigma becomes enlarged to form a small sphere (Fig. 1, A and B), and then grows more on one side than on the other so that as the spore rapidly enlarges it becomes more or less reniform (Fig. 1, C).

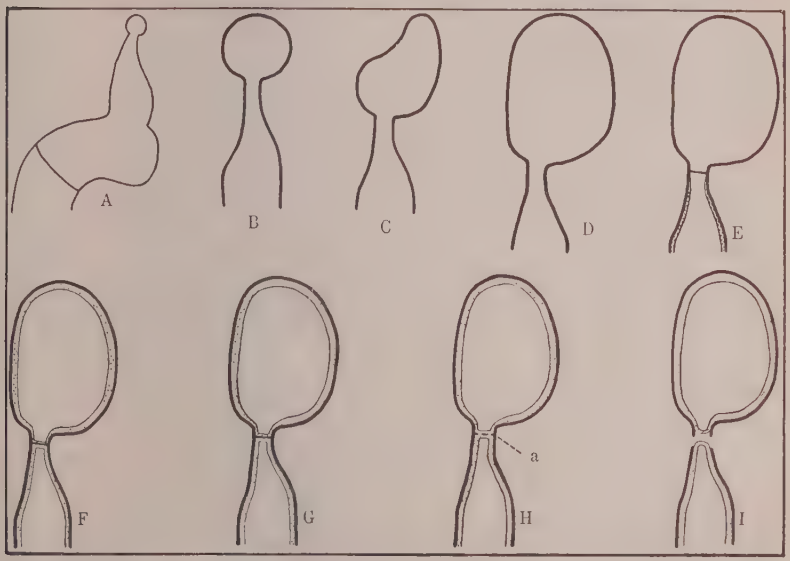


FIGURE 1.—Semidiagrammatic representation of basidiospore development and discharge. - The heavy outer line represents the primary wall common to the basidium, sterigma and spore. The secondary wall is shown by the dotted areas within the outer wall. The broken line at (a) represents the wall plate that apparently hydrolyzes and may exert a pressure which assists in spore discharge. For further explanation see text.

When the spore reaches its mature size (Fig. 1, D), there is formed a short distance from the spore in the sterigma a wall plate (Fig. 1, E) and this closes the opening between the sterigma and the spore, producing the apiculus. The formation of the disc-shaped wall plate is followed by a wall that is laid down inside the primary wall and above the disc by the spore, and below the disc by the sterigma (Fig. 1, F), the result being that the wall plate becomes a middle lamella bordered peripherally by the very tenuous original wall (Fig. 1, G) that is common both to the developing spore and to the sterigma. At this stage in the development, the spore, sterigma, and basidium have a very tenuous outer, primary wall with a thicker secondary wall on the inside. When pressures are built up in the apiculus of the basidiospore and in the apex of the sterigma by the periplasm, the original wall acts

as a retaining membrane until the pressures become sufficiently great to rupture it suddenly, thus permitting the instantaneous bulging of the end wall of the sterigma and of the apiculus, and resulting in the forceful discharge of the spore (Fig. 1, I). It is possible also that just prior to spore discharge there is either a partial or complete hydrolysis of the middle lamella, (Fig. 1, H, a), and this would serve not only as a structure for disjunction, but might even exert some pressure against both the spore and sterigma.

A comparison of the method outlined above with the method of spore discharge in *Entomophthora* (Thaxter, 1888) and *Sclerospora* (Weston, 1923) leads one to believe that the discharge phenomenon is essentially the same whenever it occurs in fungi. The reasons for making such a comparison will be given in paragraphs to follow.

This discussion would not be complete without a consideration of the droplet that is given off from the basidiospore. It is difficult to understand or explain its existence, but it may be supposed that the emission of the droplet is a means by which the pressures that must exist in the spore and sterigma are equalized so that at the moment of discharge the expanding surfaces of the sterigma and apiculus may bulge instantaneously with equal force.

That the droplets play a mechanical part (Ingold, 1939) in the discharge of the spores is doubtful because nearly mature teliospores can be placed in water and the spores will still be discharged in the normal way. Even the droplet or droplets can be seen as they are given off and this is interesting for another reason since it indicates, as has been supposed, that the droplets contain certain substances in addition to water.

The facts ascertained by the writer tend to substantiate, in part, and extend those recorded by previous investigators among whom Brefeld (1877) was apparently the first to see basidiospores of a Hymenomycete discharged violently from their sterigmata, but he thought all the spores were discharged at once as a result of a bursting of the ends of the sterigmata, and that water drops were left on the apices of the sterigmata after the spores had gone. However, Schmitz (1843) was the first to see basidiospores of a Hymenomycete leave their sterigmata, but he did not realize they were discharged since he definitely stated (p. 434) that the spores fall from their sterigmata one at a time.

Subsequently Fayod (1889) in discussing this same problem mentions that Zalewski (1883) confirmed Brefeld's observations but that he, Fayod, could not agree that the ends of the sterigmata were open after the discharge of the basidiospores. Instead he observed that there was formed at a hilum located at the septum, which separated the spore from the sterigma, a droplet which grew to a certain size. This droplet, he claimed, hydrolyzed the middle lamella and was followed by a sudden distension of the end of the sterigma, a result of the sudden expansion of the basidial content as indicated by the rounded end of the sterigma.

He also saw that the spores of a single basidium were not discharged simultaneously as suggested by Brefeld (1877) but that they left their sterigmata one at a time, and that the basidia remained turgid after their spores were discharged.

The first to publish that basidiospores of rusts were forcibly discharged was Klebahn (1904) who observed that, when fresh telial sori of *Gymnosporangium* were placed in conditions favorable for teliospore germination, basidiospores could be seen a few millimeters away from the sori; thus he concluded that the sterigmata had the power to discharge their spores and this experiment was confirmed by Falck (1904), and was later repeatedly verified by Weimer (1917), Giddings (1918) and Buller (1924).

Massee (1906) observed that in Hymenomycetes the mature basidiospore was cut off from the apex of the sterigma by a transverse septum and that the parietal protoplasm remained in the sterigma. In addition he stated that, when a spore was discharged, the force came from an accumulation of water in the basidium which had an elastic wall and, when the tension became great enough, the wall over the end of the sterigma ruptured "in a circular manner just below the septum at its apex, the elastic wall of the sterigma instantly contracts and forces its contained water to strike the apical transverse wall, which is thrown off along with the spore seated on it." The present investigations show, not that the end of the sterigma ruptures in a circular manner to leave a pore when the spore is shot off, but that a septum is formed in the sterigma, bordered on both surfaces by the wall of the apiculus and sterigma, thus preventing the extrusion of water and making it impossible for the septum to be shot off with the spore.

Dietel (1912) stated that the studies of Klebahn (1904) were the most complete and accurate up to that time. He made further observations on the discharge of basidiospores in different species of rusts. In the case of a species of *Coleosporium* he reported that at the base of mature basidiospores there appeared a droplet which enlarged rapidly until at the end of 40 seconds it had reached a diameter of 9–10 $\mu$. This caused the spores to be pushed a little to one side and apparently brought about the rupture of the spores from their sterigmata because these basidiospores were observed to have suddenly discharged and carried their droplets with them. In addition, Dietel found that there was a difference in the time necessary for the production of basidiospores between species in *Puccinia* and *Coleosporium*, the time from teliospore germination to basidiospore discharge in the former was 2½ to 3 hours while that for *Coleosporium* was 3½ to 4 hours, but in both genera a half hour was all that was necessary for the formation and discharge of the basidiospores. The writer's investigations in *Gymnosporangium nidus-avis* confirm the amount of time it takes for the teliospores to germinate and produce basidiospores although it was found that germination could be

controlled to a great degree by temperature. Thus 8 to 10 hours were necessary for germination at 5° C., whereas a minimum of only 2 hours were necessary at a room temperature of about 24° C., but above this temperature the heat definitely retarded germination. As for the observations of Dietel on the time it takes for the water drop to form, the size and function of the droplet that is exuded from the basidiospores, the author can only state that this is not in agreement with what is true in *G. nidus-avis*, but there is no reason why the size of the drop and the time necessary for its formation should not vary widely, depending upon the fungus that is being studied. In *G. nidus-avis*, the single droplets form in about 5 to 15 seconds, depending upon their size and never did a droplet reach a diameter that equaled the width of the spore or more than 8 $\mu$ in diameter. The droplet shown in Plate 1, I is 5 $\mu$ while the one in Plate 1, J is approximately 3 $\mu$.

Coons (1912) in addition to presenting a nearly complete historical resumé of the facts concerning spore discharge, demonstrated that ether and chloroform inhibited basidiospore discharge in *Gymnosporangium juniperi-virginianae*, and therefore concluded that the actual discharge must be dependent upon protoplasmic activity unless the vapors of chloroform and ether affected the turgor relations within the spores and basidial cells. Furthermore, Coons verified the fact that basidiospores are forcibly discharged from their sterigmata following the formation of a droplet which is excreted and that the actual discharge is the result of a rapid bulging of the two flat-end walls of the apiculus and sterigma. The presence of a cross-wall in the sterigma was again confirmed by Hiley (1919) during his investigations of *Fomes annosus*.

The "Researches" of Buller contain most of our present knowledge concerning basidiospore formation and discharge. Buller (1909) postulated that basidiospore discharge in the Hymenomycetes was comparable to but distinct from conidial discharge in the phycomycetous *Empusa;* however, he was unable to establish this because he could not prove conclusively that there was a double wall between the spore and the sterigma, and several years later he (1922, pp. 22–24) abandoned this theory on the grounds that the septum between the spore and the sterigma could not be seen and furthermore following certain experiments stated that a septum was not necessary for the process of discharge. Earlier, however, Buller (1915) was successful in establishing the observation of Fayod that a droplet was formed at the hilum of a basidiospore just prior to the discharge. Buller (1924) in a comparison of the basidia in Hymenomycetes and Uredinales stated that in rusts (1) at the beginning of spore development, the basidiospores first form a projection, the hilum, at one side of the point where the spore joins the sterigma; (2) the axis of the spore is always inclined to the axis of the sterigma; (3) the four spores are discharged from their sterigmata in succession, not all at once; (4) the spores are shot a distance of 0.4–0.85 mm.;

(5) a droplet is formed at the hilum 10–40, often 15, seconds before the spore is discharged; (6) after the droplet has reached a certain size it is discharged with the spore; (7) the basidia or sterigmata do not collapse at once after the discharge, neither do the sterigmata bear water drops. My own observations substantiated by photographs shown in Plate 1, do not confirm the first two statements of Buller that the hilum is the first structure of the spore to be formed, or that the axis of the basidiospores is always inclined to the axis of the sterigma, but on the other hand there is no reason to believe that what is true in *Gymnosporangium nidus-avis* is true for all the rusts. There is neither a distinct structure on the basidiospores of *G. nidus-avis* that can be called a hilum in the sense that Buller has used the term, nor is the axis of the basidiospores always inclined with the axis of their sterigmata, but the two axes often seem to be parallel except in an intermediate stage of growth. The third point that the spores are not discharged all at once but in succession confirms the original observations of Fayod (1889) in the Hymenomycetes and of Dietel (1912) in the Uredinales, and was again shown to be true during the progress of the present investigation. Concerning the fourth point, the distance the spores are discharged, Dietel (1912) reported that spores may be discharged 0.3 mm. vertically and up to 0.85 mm. horizontally, with the approximate velocity of 8 cm. sec. The writer found that, if a greased cover glass was placed about 0.4 mm. above a telial sorus that was discharging spores, a few would stick to the glass, but at 0.5 mm. or higher no adhering spores could be found, although, if the glass cover was fixed so that it was barely above the telium, many spores could be found on the under side. The last three of Buller's points confirm the important facts described by Fayod (1889) in the Hymenomycetes and Dietel (1912) in the Uredinales, and it should be stated that with the exceptions already given the writer has again confirmed these facts. In *G. nidus-avis* the water droplet is excreted from 5 to 15 seconds before the basidiospores are discharged, the droplet may appear as a single large one that may reach a size of 7 $\mu$ but is usually less than 5 $\mu$ in diameter, or several small droplets may be given off in rapid succession, but only occasionally do the droplets remain on the spore until the latter is discharged. There appears to be no definite size for the droplet to reach before discharge takes place in the species under consideration and, as has been previously mentioned, the basidia and sterigmata remain turgid for some time after they have lost their spores.

In reference to the actual mechanism of spore discharge, previous theories with the exception of the one presented by Fayod (1889) are skillfully summarized by Ingold (1939, pp. 81–86) who supports the suggestion of Buller (1922) that the discharge may be caused by the force of surface tension found on the surface of the exuded droplet, but after proving by mathematical formulae that there is more than enough

energy stored on the surface of the droplet to account for the initial velocity of the spore, he has concluded with the statement that "it is not easy to see how this energy can be mobilized to bring about discharge."

The most recent consideration of the problems in basidiospore discharge is given by Lohwag (1941) who states that there is no evidence of a septum between the basidiospore and sterigma, a statement that seems to confirm the observations of Buller (1922). In addition, Lohwag presents a theory different from any Buller or Ingold have postulated. Lohwag believes that, as in the discharge of spores from the ascus, the force that discharges the basidiospores originates from a turgid basidium, the pressure being developed by osmotically active substances. For the discharge to take place, there must be a weak point somewhere between the spore and sterigma and this point is found at the top of the sterigma where it is attached to the spore. If this weak point is constructed similarly to the apex of an ascus with an operculum, then if the pressure from within becomes great enough or if the balance of the spore on the sterigma is disturbed, a tearing of the spore from the sterigma will take place. Only the slightest change in the balance of the spore on the sterigma is necessary to bring about the tearing away of the spore from the sterigma. An example of this is found in *Calocera cornea* in which the spore is attached off-center to the sterigma resembling a lever with unequal arms attached weakly at the fulcrum. The droplet is exuded from the spore at the end of the short arm of the lever thus causing the spore to alter its position and resulting in the breaking away of the spore from the sterigma at the weakly constructed apex. At the same time, the internal pressure of the basidium causes the spore and its drop to be forcefully discharged. There is little evidence to warrant the acceptance of this theory.

A better explanation for the method of spore discharge in *Gymnosporangium nidus-avis* can be arrived at by comparing the spore discharge in this species with what is known about this phenomenon in Phycomycetes. This is a comparison previously made by Buller (1909) but rejected later (1922) after he apparently failed to find in the sterigma a double wall which is prerequisite to this theory of spore discharge. Buller (1909) uses the drawings of Nowakowski as a basis of his theory, while Thaxter (1888) stated that the findings of the latter delineator had to be considered as abnormal for the *Entomophthoraceae*. Thaxter (1888) has shown that the conidia of *Entomophthora* are covered with a delicate membrane which is continuous with that of the conidiophore. He stated further that the conidia take on water until the base of the spore presses downward against the columella, until sufficient pressure is exerted to rupture the membrane holding the conidium to the conidiophore and thus bringing about discharge. This method of spore discharge has been further emphasized and accurately depicted by Weston (1923) for *Sclerospora philippinensis* in which species the discharge of

the spores resulted from the sudden bulging of the end wall of both sterigma and apiculus to break the surrounding membrane, the remains of which are evident on the discharged conidia as a narrow ragged collar at the point where the spore was attached to the sterigma. The comparison of conidial discharge in *Entomophthora* and *Sclerospora* with basidiospore discharge in *Gymnosporangium* may not at first appear valid, but if nuclear behavior prior to spore formation be excluded in these groups and if only the morphology and the development of the two types of spores be considered, it becomes obvious that the methods of spore discharge are similar, if not identical. In both groups the spores are formed by a bulging out of the apex of the spore-bearing structures followed by the laying down of septa at the base of the spores within the original walls that surrounded the apiculi and spore-bearing structures. The spores in both groups are discharged forcefully and the mechanics involved appear to be the same, that is, there are surfaces of two structures exerting force against each other and these surfaces are held together by a common membrane and not until it is ruptured can the forces thus involved be transformed into motion. The only structural difference between the two Phycomycetes mentioned and the species of *Gymnosporangium* under consideration is that in the latter there is a relatively thick middle lamella interposed between the spore and sterigma. If it can be accepted as true that the method of discharge in these forms is the same, and all the evidence seems to confirm this, then the method of spore discharge presents a striking instance of independent and parallel development in two widely separated groups of fungi.

## SUMMARY

The developmental stages of germinating teliospores of *Gymnosporangium nidus-avis* Thaxter have been observed and photographed. The basidium was found to have an inner and outer wall, the latter being common also to the sterigma and spore, the inner wall common only to each cell. It is suggested that in the light of the recent work of Olive (1942) the basidium may be compared to an ascus with four spores. Basidiospore discharge was found to be dependent, not on the presence of a droplet as suggested by Lohwag and others, or on the sudden expansion of the basidium as suggested by Fayod, but rather the process is comparable to the one found in the *Entomophthoraceae* and *Sclerospora*. An explanation of the phenomenon of basidiospore discharge, based on these investigations, is described and illustrated. The present theory of spore discharge is compared with those of previous investigators.

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## EXPLANATION OF PLATE 1

**A:** Basidium with narrow stipe cell formed when the teliospore germinated deep in the telial matrix. **B:** Teliospore germinating on the surface of the telial matrix producing a basidium without an evident stipe cell. A sterigma has started to form on the third basidial cell. **C:** An early stage in the formation of a basidiospore showing the globose enlargement at the end of a sterigma. **D-E:** The young spore grows more on one side, elongates upward becoming more or less reniform. **F:** Sterigma bearing a fully enlarged spore. **G-H:** A septum, indicated by arrow, is formed in the sterigma a short distance below the spore forming an apiculus, hyaline material becomes concentrated in the apiculus. **I-J:** Hyaline material is evident (J) at the apex of the sterigma and a droplet appears on the flattened side of the spore just before discharge. **K:** The end of the sterigma after discharge has a definite convex wall. **L-M:** Note hyaline material in the tips of the two sterigmata in focus, and that after spore discharge (a) the apex is convex indicating pressure from within. The two left hand spores are from one basidium, the right hand one from another. Pictures taken 8 minutes apart.

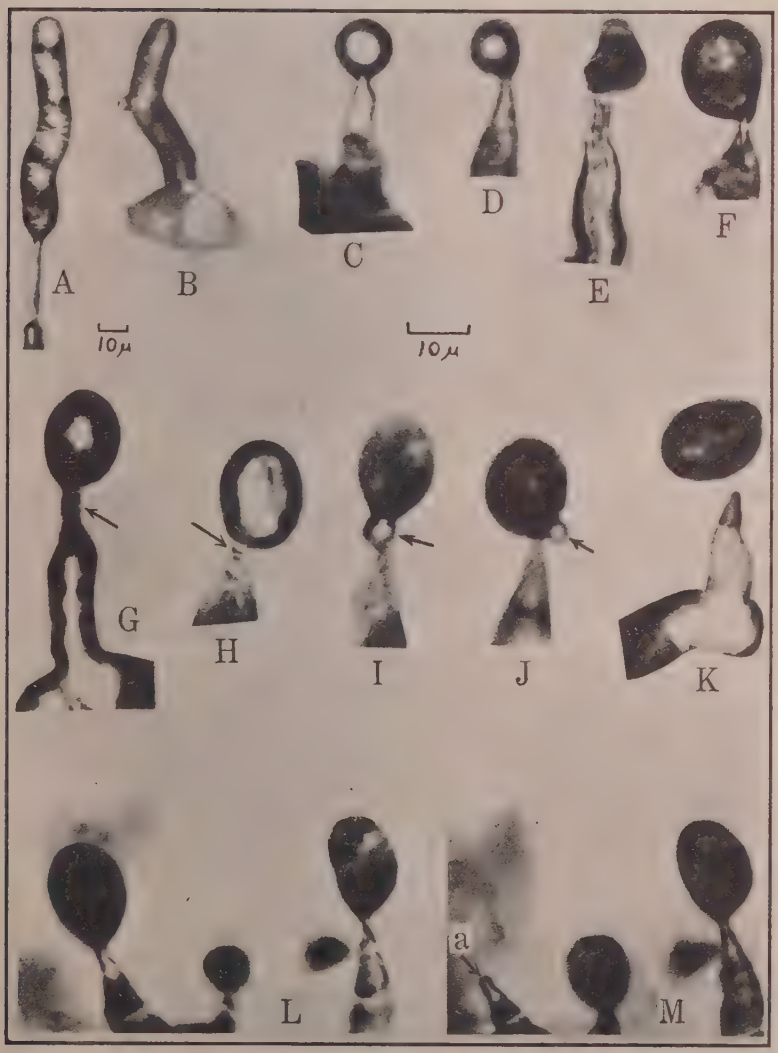


PLATE 1

1(1): 95–118 FARLOWIA January, 1943

# THE GENUS PELLICULARIA (THELEPHORACEAE) [1]

Donald P. Rogers

Since the completion of my account of the genus *Botryobasidium* (Univ. Iowa St. N. H. **17**: 10–19. 1935) many additional specimens have been collected or otherwise become available for examination, including material of eight additional species; and the necessity of adoption of the earlier generic name *Pellicularia*, and of a revised nomenclature for some of the species, has become inescapable. The present treatment is as inclusive as accessible material would permit, and the nomenclature is that determined by strict application of the Rules to the established or probable synonymy. Without any doubt there are species yet undescribed that belong in *Pellicularia*, and others, already described among the multitude of fungi assigned to *Hypochnus*, *Corticium*, *Peniophora*, or more unlikely genera, unrecognized or unrecognizable as members of the present group. It is not to be expected that this discussion can serve as a monograph of *Pellicularia:* some of the specific units as here broadly defined may be found susceptible of dissection into smaller but still natural units, names will be displaced on the legitimate ground of priority, and other species will be added. The most that is to be hoped for is that a nucleus may here be found around which to assemble information concerning a natural and, from the standpoint of phytopathology as well as mycology, important group of organisms.

It will be observed that components of *Pellicularia* have been drawn impartially from *Hypochnus*, *Corticium*, and *Peniophora*. It has many times been argued, and may now be regarded as settled, that *Hypochnus* as defined by looseness of hymenial texture ("lack of a true hymenium") is a concept as unworkable as it is unnatural. That some components of *Peniophora* are much more closely related to components of *Corticium* than to others included in *Peniophora* must be fully as apparent to even a casual student of those genera; and both genera, in their present inclusive sense, are to be tolerated only until a more natural arrangement of species can be worked out. *Pellicularia*, like *Aleurodiscus* and *Vararia*, is a genus, whereas *Corticium* and *Peniophora* are at present only heterogeneous accumulations.

It has been considered unnecessary to cite data, or locations in herbaria, for most specimens examined. Critical material has been identified sufficiently in the text to indicate the bases for some of the taxonomic conclusions arrived at. Herbaria are referred to, after citation of the specimens, according to the scheme presented by Lanjouw (Chron. Bot. **5**: 142–150. 1939.): BPI = Pathological and Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture; FH = Farlow Herbarium, general collection; FH-B = its Burt collection; FH-C = its Curtis collection; FH-H = its von Höhnel collection; FH-P =

[1] Contribution from the Department of Botany, Brown University.

its Patouillard collection; FP = collections of the Division of Forest Pathology, New Haven; IA = Mycological Herbarium of the University of Iowa; MICH = Herbarium of the University of Michigan; OTB = Herbarium of the Division of Botany, Central Experimental Farms, Ottawa; SP = Herbario da Seccão de Fitopatologia, Instituto Biologico, São Paulo, Brazil (specimens lent by H. S. Fawcett); TENN = Herbarium of the University of Tennessee; TRT = Herbarium of the University of Toronto; D.P.R. is here used for my own herbarium. Color names followed by (R) are used in the sense of Ridgway.

Material examined was uniformly treated according to the highly satisfactory KOH-phloxine technique introduced by Martin (Mycologia **26:** 264. 1934.). Species not here illustrated have already been figured in the cited discussion of *Botryobasidium*. All figures were drawn with the camera lucida at 1960 × and reduced in reproduction to 1000 ×.

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**PELLICULARIA** Cooke, Grev. **4:** 116. 1876; **4:** 134. 1876.

*Corticium* [Sect.] *Botryodea* Bourd. & Galz., Soc. Myc. Fr. Bul. **27:** 247. 1911; Hym Fr. 238. [1928]; Overh., Mycologia **26:** 509. 1934.

*Tomentella* Sect. *Tomentellastrum* [Subsect.] *Botrytes* Bourd. & Galz., Soc. Myc. Fr. Bul. **40:** 137. 1924; Hym. Fr. 481. [1928].

*Botryobasidium* Donk, Nederl. Myc. Ver. Med. **18–20:** 116. 1931; Rogers, Univ. Iowa St. N. H. **17:** 10. 1935.

*Botryohypochnus* Donk, Nederl. Myc. Ver. Med. **18–20:** 118. 1931.

Type: *P. Koleroga* Cooke.

Fructification resupinate, mucedinoid or hypochnoid, reticulate-pellicular, finely granulose, under the lens more or less tufted, or even and loose-membranous; hyphae strongly stainable in aniline blue, thick, short-celled except for basal strands, branching at right angles and often with the formation of cruciform cells, the ascending hyphae usually several times cymosely divided, bearing the terminal basidia in more or less candelabrum-like clusters, or in parasitic species sometimes rela-

tively short and little divided; basidia subcylindric, not greatly exceeding in diameter the supporting cells, relatively short, bearing 4 or in several species 6–8 sterigmata; spores smooth-walled or rarely asperulate or spinulose, colorless or pale ochraceous; cystidia wanting, or present and of various forms. Saprobes or facultative parasites.

*Pellicularia* is distinguishable by very short-celled, stout hyphae (of which some portions in every species except *P. chordulata* attain a diameter of 10–18 $\mu$), by right-angled branching of the mycelium, by very stout basidia, and by mucedinoid texture.

The genus *Botryobasidium* Donk is a distinct and well characterized systematic and phyletic unit, for which the need had long existed. *Pellicularia* Cooke, of which *P. Koleroga* is thus far the only species, was described by its distinguished author as subgelatinous, lacking basidia, having echinulate and sessile spores, and falling somewhere near "*Oidium*" (i. e., the imperfect stage of certain powdery mildews). Nevertheless, *P. Koleroga* is a good *Botryobasidium*. There seems to be no earlier genus named *Pellicularia;* and Miss Wakefield's sketches of the type specimen of *P. Koleroga*, published by Burt, show both basidia and spores. Consequently, *Pellicularia* cannot be disposed of as would be most appropriate — at least, not through invocation of Art. 57 or Art. 61 of the Rules. Furthermore, *Botryobasidium* cannot be regarded as sufficiently well established to deserve the application of the greatly overworked principle of *nomina conservanda*. There is no choice but to reduce *Botryobasidium* to synonymy, and to take up as soon as possible the valid name *Pellicularia*.

KEY TO THE SPECIES

1. Spores rough-walled ..... 2
1. Spores smooth-walled ..... 4
2. Clamps present in subhymenial hyphae; spores asperulate, subglobose ..... **1. chordulata**
2. Clamps lacking ..... 3
3. Spores subglobose, even or angular in outline, spinose ..... **2. isabellina**
3. Spores ellipsoid, minutely asperulate ..... **3. asperula**
4. Cystidia present, emergent ..... 5
4. Cystidia lacking ..... 8
5. Cystidia septate ..... 6
5. Cystidia aseptate ..... 7
6. Clamps absent from cystidia and mycelium; cystidia stout, brown-encrusted ..... **4. Langloisii**
6. Clamps present on cystidia and mycelium; cystidia unencrusted or with a few loose colorless mineral platelets, slender .. **5. cystidiata**
7. Cystidia thick-walled at the base, becoming very thin-walled toward the apex; spores thick-walled ..... **6. ochroleuca**
7. Cystidia thin-walled (or with walls uniformly slightly thickened); spores thin-walled ..... **7. ansosa**
8. Clamps present ..... **8. subcoronata**
8. Clamps lacking ..... 9
9. Fructification formed on dead plant parts or on soil; saprobes ..... 10
9. Fructifications formed on living plant parts. or on soil in contact with living plants; parasites ..... 13

10. Spores germinating by repetition, with large, truncate apiculus; sterigmata (2–) 4, very large ..... **9. flavescens**
10. Spores not germinating by repetition, with small apiculus; sterigmata relatively small ..... 11
11. Spores 4–7 (–7.5) μ long, subglobose to broadly ellipsoid-fusiform ..... **10. pruinata**
11. Spores 7–12 μ or more long, fusoid-cylindric to navicular ..... 12
12. Hyphae mostly 8 μ or less in diameter; spores slender-navicular, 7–9 x 2.5–3.5 μ ..... **11. lembospora**
12. Many hyphae 10 μ or more in diameter; spores variable, in most collections larger than 7.5 x 3.5 μ ..... **12. vaga**
13. Spores subcylindric to elongate-ellipsoid, flattened or depressed on the inside, slightly thick-walled ..... **13. Koleroga**
13. Spores relatively broader, ellipsoid, oblong-ellipsoid, or ovate. not at all depressed, thin-walled ..... 14
14. Spores ellipsoid or oblong-ellipsoid ..... **14. filamentosa**
14. Spores ovate, 5.2–7.8 x 4.9–5.5 μ ..... **15. C. praticola**

1. **Pellicularia chordulata** sp. nov.

FIGURE 1.

Fructificatio tenuis, hypochnoideo-membranacea, alutacea; hyphae (3.5–) 4.5–6 (–8) μ diam., basales vel in chordulis fasciculatae vel liberae, passim nodoso-septatae (ansis anastomosis 3–4.5 μ crassis), breviter articulatae. hyalinae vel paululo luteotinctae, subhymeniales ubique nodoso-septatae, tenuiter tunicatae; basidia in cymis regularibus producta, subcylindracea, 12.5–16–21 x 6–7–8 μ, sterigmata 4 divergentia 2–4.5 (–6) μ longit. gerentia; sporae subglobosae, 4–5.5 x 4–4.5 μ, asperulae, tunica leviter incrassata, apiculo conico, 1 μ longit.

Fructification thin, hypochnoid-membranous, under the binocular minutely reticulate-poroid, even or irregularly granulose, readily separable, when dry Cartridge Buff (R) to a color between Light Buff (R) and Warm Buff (R); all parts strongly stainable by aniline blue; hyphae (3.5–) 4.5–6 (–8) μ in diameter with the thickest and thinnest portions both among the free subicular strands, the basal in part compacted into firm cords, hyaline or only slightly tinted, anastomosing but with only very rare clamps, and in part distinct, short-celled, branching at right angles, with clamps at many septa 3–4.5 μ thick, giving rise to thinner-walled subhymenial branches, short-celled, with clamps throughout; basidia in candelabrum-like clusters, subtended by strong proliferating clamps, clavate-subcylindric or slightly barrel-shaped, 12.5–16–21 x 6–7–8 μ, bearing 4 divergent sterigmata 2–4.5 (–6) μ long; spores nearly globose, slightly flattened on the inside, 4–5.5 x 4–4.5 μ, the wall slightly thickened and ochraceous-tinted, asperulate, the apiculus distinct, conic, hyaline, 1 μ long.

On dead bark and wood of *Populus tremuloides*, *Salix* sp., and *Tilia americana*.

Specimens examined: ONTARIO, Gull L. Pt., L. Temagami, VIII.20.36, *R. Biggs* (TRT *10408*); Sandy Inlet, L. Temagami, VIII.12.31, *G. E. Thompson* (TRT *2464*); Rondeau Gov't Park, VIII.15.34, *R. F. Cain* (TRT *7286*); OHIO, Ten Mile Cr., west of Toledo, VIII.12.35, *D. P. Rogers 946*, **type**, and *947*; IOWA, Wellman, VIII.30.32, *L. W. Miller* (IA, D.P.R. *948*).

A species readily distinguished by the asperulate (rather than spinose) spores, clamp-bearing mycelium, and prominent subicular cords. In spore-ornamention, in possession of cords, and in mycelium more delicate than that of most species of *Pellicularia*, the present fungus approaches *Corticium* sect. *Humicola* of Bourdot & Galzin. In the keys of the *Hyménomycètes de France* it would be associated with *C. sulphureum*, or might be sought near *C. araneosum* or (in *Tomentella*) in the same bracket with *T. testaceogilva*. In Burt's keys to *Hypochnus* the specimens cited would be assigned to *H. sparsus*, which, however, has typical long basidia, strong sterigmata, and the angular-spinose spores of a *Tomentella*, and mycelium not approaching that of a *Pellicularia*.

2. **Pellicularia isabellina** (Fries) comb. nov.

*Thelephora isabellina* Fr., Epicr. 544. 1838.

*Hypochnus isabellinus* (Fr.) Fr., Summ. Veg. Scand. 337. 1849; Bres., Ann. Myc. **1**: 106. 1903; Burt, Mo. Bot. Gard. Ann. **3**: 222. fig. 12. 1916; Wakef., Br. Myc. Soc. Tr. **6**: 133, 1919; nec *H. isabellinus* sensu Schroet. in Cohn, Krypt.-Fl. Schles. **3 (1)**: 417. 1888.

*Corticium isabellinum* (Fr.) Fr., Hym. Eur. 660. 1874; Mass., Linn. Soc. Bot. Jour. **27**: 149. 1890; nec *C. isabellinum* sensu Pat., Tab. Anal. **1**: 16. fig. 23. 1883, nec sensu Eichl. ex Bres., Ann. Myc. **1**: 98. 1903.

*Hypochnus argillaceus* Karst., Soc. Faun. Fl. Fenn. Med. **6**: 13. 1881; Bidr. Känned. Finl. Nat. Folk **37**: 164. 1882.

*Lyomyces isabellinus* (Fr.) Karst., Bidr. Känned. Finl. Nat. Folk. **37**: 153. 1882.

*Zygodesmus argillaceus* (Karst.) Karst., in Rabenh.-Wint., Fungi Eur. *3188*. 1884; Bidr. Känned. Finl. Nat. Folk **51**: 420. 1892.

*Odontia tenerrima* Wettst., Zool.-Bot. Ges. Wien Verh. **38**: 178. 1888.

*Tomentella flava* Bref., Unters. **8**: 11. pl. 1, fig. 11–14. 1889.

*Hypochnus flavus* (Bref.) Sacc., Syll. Fung. **9**: 242. 1891.

*Tomentella ochraceo-viridis* Pat., Soc. Myc. Fr. Bul. **9**: 134. 1893; Cat. Pl. Cel. Tunisie 63. 1897.

*Tomentella isabellina* (Fr.) Höhn. & Litsch., Ak. Wiss. Wien, Math.-Nat. Kl., Sitzungsb. **115, 1**: 1570. 1906; Wiesner-Festschr. 78. 1908; Bourd. & Galz., Soc. Myc. Fr. Bul. **40**: 137. 1924; Hym. Fr. 482. fig. 121. [1928].

*Botryobasidium isabellinum* (Fr.) Rogers. Univ. Iowa St. N. H. **17**: 11. pl. 2, fig. 5. 1935.

*Hypochnus isabellinus* Fr., Obs. Myc. **2**: 281. pl. 6, fig. 3. 1818.

Fructification arachnoid-pruinose, soon becoming granular, loose-hypochnoid and relatively thick, at first whitish, soon buff or isabelline, when dry Ivory Yellow (R) to Clay Color (R) and Sayal Brown (R), under the binocular uniformly hypochnoid; hyphae short-celled, 6–14 $\mu$ in diameter, branching at right angles, without clamps, hyaline to ochraceous, in older portions the basal strands usually brownish-ochraceous and with bilamellate walls; basidia clavate-cylindric or clavate-obovate, not constricted at the septum, 15–25 x 8–11.5 $\mu$, bearing 4 strongly divergent sterigmata 3.5–6 $\mu$ long and 2–3 $\mu$ thick at the base; spores mostly somewhat ochraceous, subglobose or subglobose-ellipsoid, in occasional specimens subangular, 6–10.5 x 5.5–9 $\mu$, tapered or more commonly abruptly giving rise to the lateral, truncate-conic apiculus, the surface marked by scattered obtuse-cylindric or obtuse-conic spines

of variable length, in the specimens where least developed 0.25–0.75 μ long, in those where best developed 2–3.5 μ and expanded at the base so as to give a subangular outline to the spore.

American specimens on soil, on dead *Pteridium latiusculum*, on bark and wood of *Abies balsamea*, *Pinus virginiana*, unidentified conifers, *Betula lutea*, *Liriodendron Tulipifera*, *Populus grandidentata*, *P. tremuloides*, *Salix* sp., *Tilia americana*, and on other hardwoods.

Specimens examined: FINLAND, Mustiala, *P. A. Karsten*, Rabenh.-Wint. Fung. Eur. *1883*, as *Z. argillaceus* (FH); SWEDEN, Upsala Halmbyboda, 1853, *E. P. Fries*, as '*Hypochnus* s. *Thelephora isabellina*' (FH-C); AUSTRIA, Steiermark, 1886, *Eberstaller*, type of *O. tenerrima* (FH-H); ECUADOR, Quito, 1892, *de Lagerheim*, type and paratype of *T. ochraceo-viridis* (FH-P); also specimens from France, Colombia, British Guiana, Nova Scotia, Quebec, Ontario, Manitoba, Massachusetts, Connecticut, New York, Pennsylvania, Florida, Tennessee, Louisiana, Michigan, Iowa, and Oregon.

Except in spore-ornamentation, the abundant material at hand is notably uniform. The spores with perfectly cylindric spines less than ¾ μ in length would seem amply distinct from those whose long, conical spines render the spore-body almost polyhedral, but the more abundant intermediates, and the lack of other variation, render the setting up of a new species for the long-spined forms a singularly pointless exercise. The only possible basis for division would be shape of spines—conical versus cylindrical—and even thus a natural cleavage could probably not be found.

Donk published a genus *Botryohypochnus* for this species (Nederl. Myc. Ver. Med. **18–20:** 118. 1931.) but did not list the new binomial.

3. **Pellicularia asperula** sp. nov.

FIGURE 2.

Fructificatio tenuissima, haud continua, mucedinoidea, albida; hyphae enodosae, angulis rectis ramosae, 4–11.5 (–14) μ diam., basales e cellulis longis compositae, interdum crasse tunicatae, luteae, fertiles creberrime ramosae, cymosae, angustiores; basidia subcylindracea, ad apicem leviter expansa, 13.5–17.5 x 7.5–8 μ, sterigmata 6–8 peripherica, 2.5–3 μ longit., gerentia; sporae ellipsoideae, uno latere subapplanatae, crasse tunicatae, asperulae, 4.5–5.5 x 3.5–4.5 μ.

Fructification delicate, discontinuous, mucedinoid, when fresh whitish, Pale Neutral Gray (R), when dry about the same (i. e., white, and allowing the substratum to show through); hyphae regular, without clamps, 4–11.5 (–14) μ in diameter, branching at right angles, usually with the formation of cruciform cells, the basal long-celled, wide, often with thickened and yellowish walls, the fertile portions with abundant cymose branching, shorter-celled, more slender; basidia subcylindric, somewhat expanded toward the summit, 13.5–17.5 x 7.5–8 μ, truncate, bearing at the periphery 6–8 divergent sterigmata 2.5–3 μ long; spores ellipsoid, somewhat flattened on the inside, fairly thick-walled, with minutely asperulate non-amyloid surface, 4.5–5.5 x 3.5–4.5 μ.

On fallen decayed hardwood limb.

Specimen examined: CUBA, Blanco's Woods, Soledad, Cienfuegos, Santa Clara Prov., VII.1.41, *W. L. White 603*, **type** (FH).

A typical *Pellicularia* in all respects but the spores. These are very abundant in the material cited, sometimes free, but often, as in other species of the genus, held in groups by the collapsed, nearly invisible basidia. Distinct mature basidia are very rare, and may vary more widely than the description allows. The form of the spores makes them unique in the genus, as does the type of wall-sculpturing; they resemble the rough-walled conidia of some species of *Aspergillus*, but have apiculi, and were seen attached to the sterigmata.

4. **Pellicularia Langloisii** (Pat.) comb. nov.

*Hypochnus Langloisii* Pat., Soc. Myc. Fr. Bul. **24**: 3. 1908.
*Peniophora magnahypha* Burt, Mo. Bot. Gard. Ann. **12**: 238. [1926].

FIGURE 3.

Fructification cream-colored, thin-hypochnoid, fragile, under the lens a continuous, minutely poroid, whitish layer, closely brown-setulose; hyphae without clamps, very short-celled, branching at right angles to form candelabrum-like fascicles, with many cruciform cells, the basal, and the main axes, slightly thick-walled, straight and rigid, up to 10–19 μ in diameter, few, the lateral branches progressively decreasing in diameter down to (3.5–) 6 μ; cystidia formed by prolongation of the main axes of the hyphal fascicles, tapering outward, obtuse, with a few septa, encrusted with orange-brown granular material, 100–160 x 9–11 μ, long-emergent; basidia borne in symmetrical cymes, subcylindric, 11–15 x 6–7 μ, bearing 4 sterigmata 3.5–5 (–6) μ long; spores smooth, hyaline, oblong, flattened or slightly depressed on the inner side (subreniform), (5.5–) 6–8 x 3–4.5 (–5) μ.

On decorticated hardwoods.

No material in addition to the type specimens has been encountered; these are from FLORIDA, Coconut Grove, *R. Thaxter 57*, *P. magnahypha* (FH), and LOUISIANA, St. Martinville, *Langlois 2968*, *H. Langloisii*, (FH-P).

A typical and highly characteristic member of this genus, distinguishable from the other cystidiate species by incrustation, septation, and lack of clamps on the cystidia. The brown incrustation persists in lactophenol but disappears in KOH. The Louisiana specimen, according to Langlois's notes, had "dents jaunes sur un blanc subiculum"; at present it is mostly disintegrated, and the Florida specimen alone shows all structural details.

5. **Pellicularia cystidiata** sp. nov.

FIGURE 4.

Fructificatio tenuis, pruinoso-hypochnoides vel mucedinoides, vix separabilis, sordide albida, sub lente minute pilosa; hyphae 4.5–6–10.5 μ diam., majori ex parte repentes, zygodesmatibus minutis ubique ornata, ramos breves atque plura cystidia emittentes; cystidia apicem versus attenuata, pauciseptata, obtusa, tenuiter tunicata, (50–) 70–110 x 6–10 μ; basidia plerumque obovata, 13–15 x 9–11 μ, sterigmata 4 gracilia, 3.5–4.5 μ longit., gerentia; sporae fusiformes, apiculum versus curvulae (8–) 11–13 (–16) x 4–5 μ.

Fructification thin, pruinose-hypochnoid or loose and mucedinoid, inseparable from the substratum or separable only in small bits, whitish with a faint yellow tinge, lighter than Pale Olive Gray (R) when dry, under the binocular loosely pilose-hypochnoid; hyphae short-celled, with relatively minute clamps throughout, 4.5–6–10.5 $\mu$ in diameter, mostly repent, giving off, in a direction about perpendicular to the substratum, fertile branches 1–6 cells long, and abundant cystidia; cystidia little differentiated, thin-walled, colorless, tapering toward the apex, obtuse, (50–) 70–110 x 6–10 $\mu$, mostly 2–6-septate and with minute clamps, with a few loosely attached plate-like mineral bodies; basidia barrel-shaped to obovate, 13–15 x 9–11 $\mu$, bearing 4 delicate sterigmata 3.5–4.5 $\mu$ long; spores subfusiform, curved toward the apiculus, thin-walled, colorless, (8–) 11–13 (–16) x 4–5 $\mu$.

On *Picea* sp. and log of undetermined conifer.

Specimens examined: ONTARIO, Constance Bay, VI.1933, *J. W. Groves* (OTB *F6335*), **type**; CONNECTICUT, N. Bloomfield, VIII.28.38, *H. G. Eno* (FP *84049*); IOWA, Iowa City, V.2.1932, *D. P. Rogers, 786*.

Distinguishable from *P. subcoronata*, which likewise has clamps at the septa, by the presence of cystidia, greater size of spores, lack of regular and extensive candelabrum-like branching of fertile hyphae, and relative inconspicuousness of the clamp-cells; distinguishable from *P. ansosa* by the occurrence in *P. cystidiata* of septate cystidia, different basidia, more delicate clamp-cells, and longer spores. The spores resemble somewhat those of *P. ochroleuca*, but are smaller and considerably more tapered — especially toward the base — than in that species, and are thin-walled whereas those of *P. ochroleuca* have strongly thickened walls; the cystidia differ in every respect.

6. **Pellicularia ochroleuca** (Bres.) comb. nov.

*Coniophora ochroleuca* Bres. apud Brinkm., Westf. Prov.-Ver. Jahresber. **26:** 130. 1898.

*Peniophora ochroleuca* (Bres.) Höhn. & Litsch., Ak. Wiss. Wien, Math.-Nat. Kl., Sitzungsb. **117, 1:** 1107. fig. 6. 1908; Bourd. & Galz., Hym. Fr. 301. [1928].

*Coniophorella ochroleuca* (Bres.) Brinkm., Westf. Prov.-Ver. Jahresber. **44:** 41. 1916.

*Peniophora fusispora* sensu Höhn. & Litsch., Ann. Myc. **4:** 289. 1906; Bourd. & Galz., Soc. Myc. Fr. Bul. **28:** 391. [1913]; Hym. Fr. 300. [1928], quantum ad descr. et specim., typo excl.; nec *Hypochnus fusisporus* Schroet. in Cohn, Krypt.-Fl. Schles. **3 (1):** 416. 1888 (= *Pellicularia flavescens* (Bon.) ).

FIGURE 5.

Fructification hypochnoid, when fresh sordid whitish or pale isabelline, occupying small separate patches on the substratum, under the binocular minutely interrupted, tufted, when dry between Warm Buff (R) and Cream Color (R), pilose, readily separable; hyphae with prominent clamps at most septa, (4.5–) 6–12 $\mu$ in diameter, short-celled, branching at right angles but lacking cruciform cells, in part soon collapsed; cystidia tapered evenly toward the apex, or up to the middle and with

the upper half subfusiform, obtuse, moderately thick-walled below, very thin-walled above, continuous, borne on stout mycelium, subtended by a prominent clamp, 95–360 x 6–12 $\mu$; basidia cylindric or thick-claviform, somewhat constricted near the middle but not at the basal septum, 18–48 x 7–10 $\mu$, bearing 4 slender erect sterigmata 3–6 $\mu$ long; spores hyaline when fresh, becoming yellowish on drying, thick-walled, evenly navicular-fusiform, obliquely apiculate, 9.5–18 x 4–8 $\mu$.

American specimens on *Pinus* sp., *Pseudotsuga mucronata*, undetermined conifer, and *Acer* sp.

Specimens examined: GERMANY, Rheinauerwald bei Rastadt, Baden, XI.1877, *Schroeter*, as *Hypochnus fusiger* (FH-H); and Lengerich, Westfalen, XI.1897, *Brinkmann*, **type** of *C. ochroleuca* (FH-B), and II.1899, Westf. Pilze *28* (FH); also specimens from France, Ontario, Massachusetts, and Oregon.

A *Pellicularia* with aseptate cystidia thick-walled at the base and thin-walled at the apex, much like those of *Peniophora subalutacea*. Under low magnification the living fructification strongly resembles columnar hoar-frost — and *Peniophora chaetophora* (Höhn.) Höhn. & Litsch. With its relatively long basidia and its hyphae lacking cruciform cells *P. ochroleuca* is far from typical of *Pellicularia*, but appears to belong in this genus.

The type of *H. fusisporus* Schroet. is not among Höhnel's specimens, nor is there even a slide of it. As the discussion in the "Revision der Corticieen in Dr. J. Schröter's 'Pilze Schlesiens'" (Ann. Myc., l. c.) only ambiguously indicates, the account of *P. fusispora* was drawn up from a specimen carrying Schroeter's herbarium name *Hypochnus fusiger*. That specimen and the type of *Coniophora ochroleuca* agree completely. But the collection data for *H. fusiger* are not those published by Schroeter for *H. fusisporus*, and it must be apparent from his description that the two are not the same. The fructification of *H. fusisporus* is said by Schroeter (l. c.) to be "ohne Endborsten" (i. e., without cystidia), while the specimen of *H. fusiger* has cystidia over 200 $\mu$ long. The spores of *H. fusisporus* are said to be "an beiden Enden stark verschmälert, fast citronenförmig," while the spores in *fusiger* are evenly tapered, and more nearly banana-shaped; in *H. fusisporus* the spores "keimen leicht und bilden oft an kurzen pfriemlichen Keimschlaüchen secundäre Sporen," while no germination is observable in *H. fusiger* or in any of the ten other specimens examined of the present species. It seems clear enough that Schroeter's *H. fusisporus* is *Pellicularia flavescens* (q. v.), and that *Corticium fusisporum* in Brinkm. Westf. Pilze *53* truly represents Schroeter's species. For the cystidiate *Pellicularia* here described, then, Bresadola's name must be used.

7. **Pellicularia ansosa** Jackson & Rogers sp. nov.

FIGURE 6.

Fructificatio alutacea, hypochnoidea, sub lente obscure pilosa, continua; hyphae conspicue nodoso-septatae, 7–10–15 $\mu$ diam., ansarum nonnullarum tunica exteriori

incrassata ad 2.5 μ; cystidia plerumque tenuiter tunicata, subcylindracea, hic illic constricta, obtusa, continua, haud incrustata, 55–120 x 8–12.5 μ; basidia subcylindracea, subventricosa, 17–29 x 8–10 μ, sterigmata (4–) 6 recurva, 4–5 μ longit., gerentia; sporae naviculiformes, attenuatae, tenuiter tunicatae, 8–9 x 4–5 μ.

Fructification buffy, about Cream Color (R), continuous, under the binocular hypochnoid, obscurely pilose; hyphae distinct, firm, with large clamps throughout, branching at right angles, 7–10–15 μ in diameter, the basal long-celled, often sending out several branches from a single cell, often with the outer wall of the clamp-cell strongly thickened (up to 2.5 μ), the subhymenial hyphae thin-walled and short-celled; cystidia arising among the basidia, thin-walled or with walls only very slightly and uniformly thickened, emergent, irregularly subcylindric to subfusiform, constricted here and there, obtuse, unincrusted, aseptate, 55–120 x 8–12.5 μ; basidia arising in simple cymes, subcylindric, somewhat constricted near the middle, usually subventricose, 17–29 x 8–10 μ, bearing (4–) 6 sterigmata 4–5 μ long and recurved; spores broadly fusiform or navicular, curved and tapered laterally to the apiculus, thin-walled. 8–9 x 4–5 μ.

On conifer wood and on bark of *Picea sitchensis*.

Specimens examined: BRITISH COLUMBIA, Cumshewa Inlet, Queen Charlotte I., V.18.24, *J. E. Bier* (OTB *F10894*, TRT); WASHINGTON, Deer L. Trail, Olympic Mts., VI.13.39, *A. H. Smith 14344*, **type** (MICH, TRT).

In its aseptate cystidia and clamp-bearing mycelium distinct from all species except *P. ochroleuca*, from which it differs in the more distinct mycelium, the thin-walled spores, the shorter and ventricose basidia, and the cystidial walls not strongly thickened toward the base. *P. ansosa* should be distinguishable from *P. ochroleuca* by examination with a hand-lens; the present species is continuous and almost imperceptibly pilose, where *ochroleuca* is areolate and bristly.

8. **Pellicularia subcoronata** (Höhn. & Litsch.) comb. nov.

*Corticium subcoronatum* Höhn. & Litsch., Ak. Wiss. Wien, Math.-Nat. Kl., Sitzungsb. **116, I**: 822. 1907; Wakef., Br. Myc. Soc. Tr. **4**: 118. 1913; Bourd. & Galz., Soc. Myc. Fr. Bul. **27**: 249. 1911; Hym. Fr. 238. [1928]; Coker, El. Mitchell Sc. Soc. Jour. **36**: 174. 1921; Overh., Mycologia **26**: 510. pl. 55, fig. 11. 1934; Rick, Brotéria ser. trim. Ciênc. Nat. **3**: 156. 1934.

*Botryobasidium subcoronatum* (Höhn. & Litsch.) Donk, Nederl. Myc. Ver. Med. **18–20**: 117. 1931; Rogers, Univ. Iowa St. N. H. **17**: 12. pl. 2, fig. 6. 1935.

FIGURE 7.

Fructification white or whitish when fresh, arachnoid or loose and continuous, under the binocular delicately pilose to compact, byssoid, when dry white or cream to buff, soft-membranous, separable but not coherent in a pellicle; hyphae with large clamps (2–4 μ thick) throughout, or more rarely wanting from occasional septa, branching at right angles, the basal hyphae comparatively long-celled and straight, in part with yellowish walls, the ascending branches short-celled, colorless, 4–7–11 μ; basidia borne in candelabrum-like clusters, subcylindric, usually

ventricose-inflated, (11.5–) 15–18 (–25) x 6–7.5–9 $\mu$, bearing 6–8 incurved sterigmata 3–4.5–6 $\mu$ long; spores slender-fusoid, thickest near the apiculus, long-attenuate to the obtuse apex, short-attenuate to the lateral apiculus (i. e., slender-navicular), or rarely broad-navicular, or fusoid-cylindric, 6.5–8.5 (–15) x (2–) 3–4 (–5) $\mu$.

Commonly on wood so completely decayed as to be difficult of identification, or on bark or sawdust; American collections on *Abies balsamea, A. Fraseri, Picea* sp., *Pinus resinosa, P. Strobus, Pseudotsuga mucronata, Tsuga canadensis, Acer* sp., *Castanea dentata, Fagus grandifolia, Populus* sp., *Quercus* sp., numerous undetermined broad-leaved and coniferous trees, and soil.

Specimens examined: GERMANY, Wannsee, Berlin, VI. 1894, *P. Sydow*, Myc. March. *4105*, as *Peniophora Greschikii*, **type** of *C. subcoronatum* (FH-H); also from Nova Scotia, Quebec, Ontario, Manitoba, British Columbia, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, North Carolina, Missouri, Idaho, and Oregon.

Readily recognizable by the abundant large clamps and lack of cystidia; distinct from other species also in the ventricose-subcylindric basidia and the (usually) very slender spores. Two collections, aberrant in the possession of only scattered clamps on the basal mycelium and of spores 7–15 x (1.5–) 2–3 $\mu$, nevertheless agree with typical material in the form of the clamps, in constant occurrence of clamps at the base of the basidia, in form of basidia, and in texture, and are placed here.

9. **Pellicularia flavescens** (Bon.) comb. nov.

*Hypochnus flavescens* Bon., Handb. 160. 1851; Fckl., Nass. Ver. f. Naturk. Jahrb. **25–26**: 291. (Symb. Myc. 1 Nachtr. 3.) 1871.

*Corticium flavescens* (Bon.) Wint., in Rabenh., Krypt.-Fl. **1 (1)**: 329. 1882; Mass., Linn. Soc. Bot. Jour. **27**: 149. 1890; Höhn., Österr. Bot. Zeits. **54**: 428. 1904; Höhn. & Litsch., Ak. Wiss. Wien, Math.-Nat. Kl., Sitzungsb. **115, I**: 1607. 1906; **116, I**: 835. fig. 17. 1907; Bourd. & Galz., Soc. Myc. Fr. Bul. **27**: 247. 1911; Hym. Fr. 239. [1928]; Wakef. & Pears., Br. Myc. Soc. Tr. **6**: 317. fig. 1920; nec *C. flavescens* Bres., Ann. Myc. **3**: 163. 1905 (= *C. teutoburgense* Brinkm., Westf. Prov.-Ver. Jahresber. **44**: 38. 1916.).

*Hypochnus fusisporus* Schroet., in Cohn, Krypt.-Fl. Schles. **3 (1)**: 416. 1888.

*Corticium fusisporum* (Schroet.) Brinkm., Westf. Pilze *53*. 1904; nec *C. fusisporum* Cke. & Ell., Grev. **8**: 11. 1879 (= *Coniophora fusispora* (Cke. & Ell.) Sacc., Syll. Fung. **6**: 650. 1888.).

*Peniophora fusispora* (Schroet.) Höhn. & Litsch., Ann. Myc. **4**: 289. 1906, et auctt. omnium, quantum ad typum, specim. descr. excl.

*Coniophora ochracea* Mass., Linn. Soc. Bot. Jour. **25**: 137. pl. 47, fig. 13. 1889.

*Corticium frustulosum* Bres., Ann. Myc. **1**: 98. 1903; Ann. Myc. **9**: 425. 1911; Bourd. & Galz., Soc. Myc. Fr. Bul. **27**: 247. 1911; Hym. Fr. 239. [1928]; Rick, Brotéria ser. trim. Ciênc. Nat. **3**: 158. 1934.

*Coniophora vaga* Burt, Mo. Bot. Gard. Ann. **4**: 251. fig. 8. 1917.

*Corticium frustulosum* var. *intermedia* Bourd. & Galz., Hym. Fr. 240. [1928].

*Corticium fenestratum* Overh., Mycologia **26**: 510. pl. 55, fig. 5. 1934.

*Botryobasidium flavescens* (Bon.) Rogers, Univ. Iowa St. N. H. **17**: 13. pl. 2, fig. 8. 1935.

*Botryobasidium ochraceum* (Mass.) Donk ex Rogers, Univ. Iowa St. N. H. **17**: 16. pl. 2, fig. 7. 1935.

Fructification at first delicately pruinose-arachnoid, soon becoming loosely and coarsely hypochnoid, on drying becoming, except in very young specimens, distinctly tufted or reticulate-floccose, or rarely continuous, whitish, sordid whitish, through Naples Yellow (R) and Warm Buff (R) to Tawny Olive (R); hyphae without clamps, branching at right angles with many cruciform cells, the basal repent and in part colored, with cells several times as long as wide, often thick-walled, up to 10–12 $\mu$ in diameter, the remainder very short-celled, thin-walled, colorless, 5–8–10 $\mu$ in diameter; basidia clavate-cylindric, little attenuated toward the base, 13–20–24 x 8–12–15 $\mu$, bearing 4 or sometimes only 2 stout sterigmata 6–9–15 x 2–4 $\mu$; spores typically with an ellipsoid-subglobose body, truncate apiculus, and obtuse distal false-apiculus, being thus asymmetrically lemon-shaped, but sometimes without the false-apiculus, and thus subglobose, 7.5–13–15 x (4.5–) 6–10 $\mu$, hyaline or with ochraceous wall, germinating by repetition.

American specimens on *Ustulina vulgaris*, bark of living trunk of *Carpinus caroliniana*, and on dead wood of *Abies balsamea, Pinus Strobus, Acer Negundo, A. spicatum, Betula* sp., *Carya* sp., *Juglans cinerea, Phytolacca decandra, Populus tremuloides, Salix* sp., *Ulmus americana*, and unidentified hardwoods.

Specimens examined: POLAND, 1900, *Eichler*, type of *C. frustulosum* (FH-H); GERMANY, Lengerich, Westfalen, X.1900, Brinkm. Westf. Pilze *53*, as *C. fusisporum*, and *155*, as *C. flavescens* (FH); AUSTRIA, Fuckel Fung. Rhen. *2396* (herb. Barbey-Boissier, Geneva); NEW YORK, Hudson Falls, IX.1.1915, *Burnham*, type of *C. vaga* and *C. fenestratum* (FH); also specimens from Quebec, Ontario, Manitoba, Maine, New Hampshire, Massachusetts, Pennsylvania, Florida, Iowa, Missouri.

*Pellicularia flavescens* is characterized among saprobic species by clavate-cylindric basidia with usually four large, often finger-like or ventricose sterigmata, by the germination of its spores by repetition, and by the broad even- and slightly thick-walled spores with subglobose body and truncate apiculus. In the earlier treatment, under *Botryobasidium*, I distinguished *flavescens* and *ochraceum* by form of spores; and it would be possible to segregate at least one more group on the same basis. Examination of further material, however, has suggested the propriety of combining rather than segregating the members of what now appears to be a single variable species. The subglobose spores characteristic of *ochraceum* differ in no respect except the absence of a distal protuberance from the lemon- or spindle-shaped spores of *flavescens*; and since the latter vary widely in the degree of development of this protuberance, and intermediates between the two types occur, the separation seems untenable. *Coniophora vaga* and *Corticium fenestratum* were in the earlier discussion assigned to *ochraceum* because of the characterization of the spores as merely "apiculate" or "broadly ovoid and rather strongly apiculate" by Burt and Overholts respectively; but the spores of the type are what may be called biapiculate — i. e., lemon-shaped — and

the same as those of *C. flavescens* sensu Höhnel & Litschauer and Bourdot & Galzin. On the other hand, the spores of the type of *frustulosum* are "fere globosa," as insisted by Bresadola (l. c., 1911), and that species is the same as *ochraceum*. The two, or three, smaller units are easier to define or to insert in a key; but the one species is the natural group.

10. **Pellicularia pruinata** (Bres.) Rogers ex Linder, Lloydia **5**: 170. 1942.

?*Hypochnus coronatus* Schroet. in Cohn, Krypt.-Fl. Schles. **3 (1)**: 418. 1888; nec *H. coronatus* Bon., Hedw. **15**: 76. 1876.

?*Hypochnus Schroeteri* Sacc., Syll. Fung. **6**: 658. 1888; i. e., *H. isabellinus* sensu Schroet. in Cohn, Krypt.-Fl. Schles. **3 (1)**: 417. 1888; nec *H. isabellinus* Fr., Summ. Veg. Scand. 337. 1849.

?*Tomentella granulata* Bref., Unters. **8**: 11. pl. 1, fig. 15, 16. 1889; nec *Hypochnus granulatus* Bon., Handb. 160. 1851.

?*Hypochnus Brefeldii* Sacc., Syll. Fung. **9**: 243. 1891.

*Corticium pruinatum* Bres., Ann. Myc. **1**: 99. 1903.

*Corticium coronatum* sensu Höhn. & Litsch., Ann. Myc. **4**: 291. 1906; Ak. Wiss. Wien, Math.-Nat. Kl., Sitzungsb. **116, I**: 832. fig. 15. 1907; Bourd. & Galz., Soc. Myc. Fr. Bul. **27**: 248. 1911; Hym. Fr. 241. [1928]; an *H. coronatus* Schroet.?

*Botryobasidium coronatum* sensu Donk, Neder. Myc. Ver. Med. **18–20**: 117. 1931; Rogers, Univ. Iowa St. N. H. **17**: 15. pl. 2, fig. 9. 1935.

?*Botryobasidium granulatum* (Bref.) Donk, Nederl. Myc. Ver. Med. **18–20**: 118. 1931.

*Corticium botryoideum* Overh., Mycologia **26**: 510. pl. 55, fig. 10. 1934.

*Corticium isabellinum* sensu Eichl. ex Bres., Ann. Myc. **1**: 98. 1903; nec *C. isabellinum* (Fr.) Fr., Hym. Eur. 660. 1874.

Fructification at first mucedinoid, under the lens arachnoid and minutely tufted, becoming tufted-floccose or finally nearly continuous, lax and easily separable but scarcely coherent, when fresh pallid or sordid-whitish, when dry Pale Smoke Gray (R) through Olive Buff (R) and Cream Buff (R) to Chamois (R); hyphae short-celled, with cruciform branching, lacking clamps, the repent basal strands 10–18 (–29) $\mu$, often relatively thick-walled and ochraceous, the subhymenial 5–10 $\mu$, colorless, with symmetrical cymose branching; basidia subcylindric, sometimes slightly constricted above the middle, short, 14–23 x 7–9 (–10) $\mu$, bearing (5–) 6 ( 8) divergent, recurved sterigmata 3–5 (–6) $\mu$ long; spores colorless, subglobose or short oblong-ellipsoid, to broad ellipsoid-fusiform, more or less attenuated toward the lateral apiculus, distally obtuse, (3.5–) 4–7 (–7.5) x 3–5 (–6) $\mu$.

Mostly on wood or bark of angiosperm hosts, and best developed on the underside of fallen logs. American specimens on *Acer macrophyllum, A. Negundo, A. rubrum, A. saccharum, Acer* sp. indet., *Alnus rugosa, Betula lutea, Carpinus caroliniana, Fagus grandifolia, Kalmia* sp., *Liquidambar styraciflua, Populus grandidentata, P. tremuloides, Prunus serotina, Prunus* sp. indet., *Quercus alba, Q. borealis, Q. macrocarpa, Salix* spp., *Ulmus* sp., *Abies balsamea, Pinus Strobus, Pseudotsuga mucronata, Tsuga canadensis, Fomes pomaceus*, indeterminate conifer and angiosperm wood, and bare soil.

Specimens examined: POLAND, **type** of *C. pruinatum* (slide, FH-H); GERMANY, Baden, im Niederwald bei Rastatt, *Schroeter*, as *H. coronatus* (FH-H); AUSTRIA, det. Litschauer as *C. coronatum;* ENGLAND, det. Wakefield as *C. coronatum*; NEW YORK, East Galway, VIII.4.1901, *Burt*, det. Bresadola as '*C. isabellinum* Eichler', det. Burt as *C. vagum* (FH-B); PENNSYLVANIA, Biglerville, *W. L. White 1070*, herb. L. O. Overholts *14503*, type of *C. botryoideum* (FH); also specimens from Sweden, Netherlands, Nova Scotia, Quebec, Ontario, Massachusetts, Rhode Island, Maryland, Virginia, North Carolina, Ohio, Iowa, Missouri, Washington, Oregon.

On the basis of a small number of selected specimens it would be possible to dismember the group here described into several species. But when a large number of specimens is compared, whatever lines may have been tentatively drawn will disappear. The chief difficulty seems to be that of separating the present species from *P. vaga.* For the present study all specimens with distinctly navicular spores were placed with the latter species, and those with spores both relatively short and quite obtuse distally were grouped together in *P. pruinata.* It would require considerable temerity to assert that this cleavage is a natural one; it is at least fairly workable. Most collections of *pruinata* have thicker and more strongly colored basal hyphae than most collections of *vaga;* most spores in *pruinata* are under 6.5 $\mu$ long, while only very rarely are mature spores of *vaga* less than 7.5 $\mu$; *pruinata* is most abundant on hardwoods and *vaga* on conifers. In the broad-leaved forests of the central states *pruinata* is much the more abundant species; in the Northwest, where *vaga* is extremely abundant, *pruinata* is almost entirely lacking; in the mixed woods of the northeastern region both occur in some abundance. An indication of distinctness, of considerable importance but little use in determining specimens, lies in the imperfect stage. Three fructifications already assigned to *P. pruinata* were discovered to be associated with *Oidium candicans* (Sacc.) Linder, Lloydia **5**: 183. 1942; in two of these I found by microscopic examination that the hyphae giving rise to the conidiophores bore also basidial tufts, and the connection is therefore certain. As noted under *P. vaga*, that species has another *Oidium* for its imperfect stage.

The nomenclature of the present species is more than commonly involved. The accepted names have been those based on *Hypochnus coronatus* Schroet., untenable from the first because of the earlier, and quite different, *H. coronatus* Bon. Furthermore, of the two specimens listed with Schroeter's description (l. c.) the second has spores measuring 9–12 x 4–5 $\mu$ and is no different from *C. botryosum* Bres., here listed under *P. vaga;* whether the first specimen (from Breslau) possessed the "short elliptic or oval" spores originally described cannot now be determined, since material of it is lacking in the Höhnel collections. The specimen described by Schroeter as "*H. isabellinus* Fries 1818 (?)" is apparently not in existence (cf. Höhnel & Litschauer, Ann Myc. **4**: 289.). As Schroeter suspected, and as Saccardo implied in renaming it *H. Schroeteri,* it is quite probably not the Friesian species. Bresadola's descrip-

tion of *C. isabellinum* (l. c.), and a specimen so determined by him for Burt, show that for him *C. isabellinum* sensu Schroet. is the fungus here under discussion. If this identity could be accepted, the correct specific epithet for the fungus would be *Schroeteri;* but in view of the relative accuracy of Schroeter's descriptions of associated species there appears to exist no sufficient reason to disregard nearly all the characteristics which he published ("Haupthyphen bis 9 μ breit . . . Basidientragende Hyphen 3–4 μ breit . . . Basidien . . . etwa 5 μ breit, mit vier Sterigmen") in deciding the probable identity of his fungus. From Brefeld's prolixities (l. c.) it is just possible to surmise that *T. granulata* is a *Pellicularia;* and since it would appear to resemble other known species rather less than the present one, it is here doubtfully listed as a synonym. Bresadola's description of *C. pruinatum* applies well to the species under discussion; a slide of the type, in the Höhnel collection, shows hyphae such as belong to either *C. coronatum* sensu Höhn. & Litsch. or *P. vaga,* but unfortunately no spores. Since the spores of *C. pruinatum* as described are rather short for *P. vaga,* it appears safe to include Bresadola's fungus here, and to employ his specific name. The round-spored extreme described by Overholts has already been discussed in Univ. Iowa St. N. H. **17:** 15.

11. **Pellicularia lembospora** sp. nov.

FIGURE 8.

Fructificatio tenuissima, arachnoidea, grisea; hyphae enodulosae, 4.5–8 (–10.5) μ crassit., angulis rectis ramosae; basidia obovata, 9–10 (–12) x 7–9 μ, sterigmata 6–8 curvula, 2.5–3 μ longit., gerentia; sporae anguste naviculiformes, ad apiculum oblique productae, 7–9 x 2.5–3.5 μ.

Fructification delicate and inconspicuous, grayish (Mineral Gray R) when collected or barely pruinose, under the binocular loose-arachnoid; hyphae without clamps, branching at right angles, 4.5–8 (–10.5) μ, the basal with walls slightly thickened; basidia borne in small, loose cymes, subglobose to obovate, 9–10 (–12) x 7–9 μ, at the base 4–4.5 μ in diameter, bearing inside the periphery of the rounded summit 6–8 curved sterigmata 2.5–3 μ long; spores slender-navicular, strongly laterally produced to the apiculus, narrowed some distance below the summit, straight or slightly curved on the inner side, convex on the outer, 7–9 x 2.5–3.5 μ.

On wood and bark of unidentified dicotyledonous species, and on *Bambusa vulgaris.*

Specimens examined (all FH): BRITISH GUIANA, Bartica, I.18.24. *D. H. Linder 731,* **type;** XII.17.23, *D. H. Linder 567.* CUBA, Santa Clara Prov.: Blanco's Woods, Cienfuegos, VII.1.41, *W. L. White 578;* Guabairo, Cienfuegos, VII.10.41, *W. L. White 950;* Central Soledad, Cienfuegos, VII.8.41, *W. L. White 824;* Mina Carlota, Sierra de San Juan, Trinidad Mts., VII.5.41, *W. L. White 749.*

A tropical fungus, approaching *P. vaga,* but differing in the obpyriform basidia, short sterigmata, slender spores strongly drawn out at the base, and slender hyphae. It is more constant in its characters than most

members of the genus. White's *824* is associated with, and, as Dr. D. H. Linder has found, connected with, the imperfect stage, *Oidium tomentosum* (Berk. & Curt.) Linder, Lloydia **5**: 204. 1942.

12. **Pellicularia vaga** (Berk. & Curt.) Rogers ex Linder, Lloydia **5**: 170. 1942.

FIGURE 9.

*Corticium vagum* Berk. & Curt., Grev. **1**: 179. 1873; Massee, Linn. Soc. Bot. Jour. **27**: 148. 1890; Coker, El. Mitchell Sc. Soc. Jour. **36**: 173. pl. 33, fig. 9, 10. 1921; Burt, Mo. Bot. Gard. Ann. **5**: 128. fig. 3 c, d. 1918; **13**: 295. fig. 3 c, d. 1926, quantum ad typum et specim. nonnul.; Bourd. & Galz., Hym. Fr. 242. [1928], quantum ad typum, descr. specim. synon. excl.; Overh., Mycologia **26**: 511. pl. 55, fig. 4. 1934.

*Corticium botryosum* Bres., Ann. Myc. **1**: 99. 1903; Höhn. & Litsch., Ak. Wiss. Wien, Math.-Nat. Kl., Sitzungsb. **116, 1**: 833. fig. 16. 1907; Wakef., Br. Myc. Soc. Tr. **4**: 117. pl. 3, fig. 15–17. 1913; Bourd. & Galz., Soc. Myc. Fr. Bul. **27**: 248. 1911; Hym. Fr. 241. [1928]; Litsch., Soc. Sc. Skoplje Bul. **18**: 176. 1938.

*Botryobasidium vagum* (Berk. & Curt.) Rogers, Univ. Iowa St. N. H. **17**: 17. 1935.

Fructification at first loosely and delicately arachnoid, becoming continuous and hypochnoid, sordid whitish or pale buffy, under the binocular distinctly ascending-tufted, when dry whitish in very young specimens, or more often Ivory Yellow (R), Cream Buff (R), or rarely Isabella Color (R); hyphae branching at right angles, (4.5–) 6–10 (–15) $\mu$, the basal relatively long-celled, often yellowish and with bilamellate membranes, the basidiophorous colorless, with short and often barrel-shaped cells, branching to form symmetrical candelabrum-like cymes; basidia blunt-cylindric, sometimes slightly inflated either toward the apex or toward the base, 13–22 (–27) x 6.5–10 (–15) $\mu$, bearing rarely 4 or 5, mostly 6–8 stout, divergent, recurved sterigmata (3–) 4.5–6 x 1.5–2 $\mu$; spores smooth-walled, colorless, 7.5–12 (–17) x (2.5–) 3.5–5 (–5.5) $\mu$ fusoid, obliquely tapered to the apiculus, only slightly curved on the inside, more strongly curved to strongly ventricose on the outside, slightly or strongly tapered to the apex.

In America occasionally on humus or on rotting herbaceous stems (*Pteridium latiusculum*), commonly on wood or bark of coniferous or broad-leaved trees: *Abies balsamea, A. magnifica, Larix occidentalis, Libocedrus decurrens, Picea canadensis, P. sitchensis, Pinus contorta, P. rigida, P. Strobus, Pseudotsuga mucronata, Taxodium distichum, Tsuga canadensis, Alnus rubra, Betula alba, Castanea dentata, Fagus grandifolia, Kalmia latifolia, Populus balsamifera, Quercus* spp., *Salix* sp., *Tilia americana,* and many other undetermined species.

Specimens examined: POLAND, III.1902, *Eichler,* type of *C. botryosum* (FH-B); GERMANY, Glatz, Grunwalder Thal bei Reinerz, *Schroeter,* paratype of *Hypochnus coronatus* Schroet. (FH-H); SOUTH CAROLINA, *Curtis,* **type** of *C. vagum* (FH-C); also specimens from Netherlands, Austria, Nicaragua, Alaska, Nova Scotia, Quebec, Ontario, British Columbia, Massachusetts, Rhode Island, New York, Pennsylvania, Tennessee, Ohio, Wisconsin, Iowa, Missouri, Idaho, Washington, Oregon, and California.

*Pellicularia vaga* is a taxonomic grouping rendered extremely difficult both by its own variability and by the confusion introduced with the inclusion, by Burt and others, of the common parasite *P. filamentosa*. There is no important variation in gross appearance, in hyphae, or, except for dimensions, in basidia; but the forms of the spores are such that one who had before him only isolated extremes might well wish to describe for them two, or even three or four, species. The spores of all specimens here included in *P. vaga* are in some degree asymmetrically fusiform — that is, what is called navicular. But besides variations in absolute dimensions, this material shows great differences in the relation of breadth to length; and some spores are decidedly obtuse, tapering only a little from the broadest portion to the apex, while others are apically cuneate. The extremes in form are to be characterized as ventricose-navicular — that is, the 'little boat' with which the spores are compared would have to be one with a fairly deep keel — and fusoid-subcylindric — that is, narrow throughout, and only a little more so at the ends than at the middle. A fresh preparation from the type of *C. vagum* shows abundant spores 9–10.5 x 3–4–4.5 $\mu$, subcylindric-navicular, and near the slender extreme; it is matched by scattered collections from Ontario and the eastern states and by the Alaskan and many Oregon specimens (fig. 9 i–j). The type of *C. botryosum* (fig. 9 a–d) is near the other extreme, with spores (8–) 9–11.5 x (4–) 4.5–5 $\mu$ and strongly tapered; it is matched by European and a good deal of eastern American material. The intergradation in the whole series at hand is, however, such that the separation of the group into taxonomic subdivisions seems unwarranted. Probably segregation on the basis of degree of taper towards the ends of the spore would yield more usable lines of separation than segregation on relative breadth; but it does not seem probable that either would define natural — that is, phyletically divergent — segregates.

Litschauer has written (l. c.) that *C. botryosum* is "not identical with *C. vagum* Berk. & Curt." There is no indication in his note whether he desired to maintain separate species for the two extremes here described, or whether he was still misled, as formerly (cf. Rogers, l. c.), by Burt's interpretation of *C. vagum*. As Bresadola observed in a note to Burt (of January 18, 1920) attached to a sheet in the latter's herbarium, *C. vagum* sensu Burt included *C. botryosum* Bres., the form subsequently described as *C. botryoideum* Overh., and *C. Solani* (Prill. Del.) Bourd. & Galz. Bourdot's description and a specimen from Litschauer show that *C. vagum* as they had learned it through Burt bears no resemblance either to *C. botryosum* or to the fungus of Berkeley and Curtis.

In material at hand I have found basidia connected by unbroken series of mycelial cells with the conidiophores of the imperfect stage, *Oidium Curtisii* (Berk.) Linder, Lloydia **5**: 201. 1942.

13. **Pellicularia Koleroga** Cooke, Grev. **4**: 116, 134. 1876; Pop. Sc. Rev. **15**: 164–167. pl. 135, fig. a–c. 1876; Linn. Soc. Bot. Jour. **18**: 461, 463. 1881; Fawcett, Jour. Ag. Res. **2**: 231. fig. 1–3. 1914.

*Erysiphe scandens* Ernst, Estudios sobre las deformaciones . . . del arbol de cafe en Venezuela. 16. fig. 5. 1878.

*Hypochnus ochroleucus* Noack apud Sacc., Syll. Fung. **16**: 197. 1902; Stevens & Hall, Ann. Myc. **7**: 53. fig. 5–8. 1909.

*Corticium Koleroga* (Cooke) Höhn., Ak. Wiss. Wien. Math.-Nat. Kl., Sitzungsber. **119, I**: 395. 1910; Burt, Mo. Bot. Gard. Ann. **5**: 123. fig. 1. 1918; **13**: 292. fig. 1. 1926; Wolf & Bach, Phytopath. **17**: 710. fig. 10. 1927.

*Corticium ochroleucum* (Noack) Burt ex Peltier, Univ. Ill. Ag. Exp. Sta. Bul. **189**: 290. 1915 (falso ut 'ochraleucum'); nec. *C. ochroleucum* (Fr.) Fr., Epicr. 557. 1838.

*Corticium Stevensii* Burt, Mo. Bot. Gard. Ann. **5**: 125. fig. 2. 1918; **13**: 293. fig. 2. 1926; Coker, El. Mitchell Sc. Soc. Jour. **36**: 174. 1921.

*Hypochnopsis ochroleuca* Noack, Inst. Agron. São Paulo, Campinas, Bol. **9**: 80. 1898 (mycelium sterile).

FIGURE 10.

Fructification a delicate, separable, subhypochnoid pellicle, sordid or buffy; hyphae branching at right angles, without clamps, 4–12 $\mu$ in diameter, the basal mostly 5–8, or occasionally up to 10 $\mu$, long-celled, little branched, sometimes colored, the subhymenial shorter-celled and abundantly branched, rigid or early collapsed, bearing basidia in very small and irregular cymose-branching clusters, the subbasidial cell often thicker than adjacent hyphal cells and widened outward; basidia obpyriform, short-barrel-shaped, or rarely short-clavate and constricted (apparently from failure of a septum to form at the constriction), 11.5–15 (–19.5) x 8.5–10 $\mu$, bearing 4 horn-like sterigmata 6–8 x 2–3 $\mu$; spores very slightly thick-walled, subcylindric-fusiform to elongate subellipsoid, in either case tapered to both ends, flattened or depressed on the inside just above the apiculus, distinctly and laterally apiculate, 10.5–16 x 3–5.5 (–7) $\mu$.

On underside of living leaves of *Citrus sinensis, Coffea* sp., *Diospyros virginiana, Pittosporum* sp., and *Pyrus communis.*

Specimens examined: Argentina, Misiones, *Fawcett & Bitancourt* (SP *2626*); Venezuela, Caracas, X. 1923, *Pittier* (BPI): Puerto Rico, Mayaguez, V.22.17, *Thomas* (FH); North Carolina, Mt. Airy, IX.2.07, *Reimer*, det. Stevens as *H. ochroleucus*, det. Burt as *C. Stevensii* (FH-B), a sterile specimen (sclerotial) with same data (FH-B), and Indian Cr., *Hesler* (TENN *14344*); South Carolina, Summerville, VII.12.41, *Jahnz* (BPI).

Distinguished from *P. filamentosa* by the elongate spores with a slightly but distinctly thickened and refractive membrane and with narrower and thick-walled apiculus. The basidia also are usually distinctive, tending toward the pyriform rather than short-clavate. In the small amount of material available there is considerable variation in the form of the spores. In the Puerto Rican collection, on coffee, they are slender and almost fusiform, and so strongly depressed as to be slightly curved (fig. 10 a–d); in the Venezuelan collection, likewise on coffee, they are

shorter and broader; in the South Carolina collection and the Mt. Airy collection (fig. 10 e–f) they are still broader and more nearly ellipsoid. There does not, however, appear to be sufficient basis for division into two species, and the treatment of Wolf & Bach, who combined *C. Stevensii* with *C. Koleroga,* is here adopted. Noack (in Saccardo, l. c.) described the spores of his fungus as being "ovoideis . . . 8½–10 x 5½–6"; it may be that his *Hypochnus ochroleucus* was not the same fungus as the one described under that name by Stevens & Hall. In that event, *H. ochroleucus,* as well as *C. ochroleucum* Burt and *C. Stevensii,* which strictly are based on his fungus, must be deleted from the synonymy here given; but the nomenclature for the specimens here cited is not to be altered on that account.

Amateurs of Lloyd's "Myths of Mycology" will do well to compare the present fungus, or description, with Cooke's several accounts of its structure and affinities (ll. cc.).

14. **Pellicularia filamentosa** (Pat.) comb. nov.

*Hypochnus filamentosus* Pat., Soc. Myc. Fr. Bul. **7**: 163. pl. 11, fig. 2. 1891 (30 Sept.); nec *H. filamentosus* Burt, Mo. Bot. Gard. Ann. **13**: 320. 1926 (= *Corticium sulphureum* (Pers. ex Fr.) Fr.).

*Hypochnus Solani* Prill. & Del., Soc. Myc. Fr. Bul. **7**: 220. fig. 1891 (31 Dec.); Müller, Biol. Reichsanstalt Land- u. Forstwiss. Arb. **13**: 205–8. pl. 1, 2. 1924; et alibi.

*Corticium vagum* var. *Solani* Burt ex Rolfs, Science n. s. **18**: 729. 1903.

*Corticium Solani* (Prill. & Del.) Bourd. & Galz., Soc. Myc. Fr. Bul. **27**: 248. 1911.

*Corticium vagum* sensu Burt, Mo. Bot. Gard. Ann. **5**: 128. fig. 3a. 1918, pro parte; **13**: 295. fig. 3a. 1926, p. p.; Petch, R. Bot. Gard. Peradeniya Jour. **7**: 288. 1922 (falso ut '*C. vagans* Berk. & Curt.'); et Auctt. plur.; nec *C. vagum* Berk. & Curt.

*Corticium vagum* subsp. *Solani* (Prill. & Del.) Bourd. & Galz., Hym. Fr. 242. [1928].

*Botryobasidium Solani* (Prill. & Del.) Donk, Nederl. Myc. Ver. Med. **18–20**: 117. 1931; Rogers, Univ. Iowa St. N. H. **17**: 18. 1935.

*Corticium areolatum* Stahel, Phytopath. **30**: 129. fig. 3, 4. 1940; nec *C. areolatum* Bres.. Mycologia **17**: 68. 1925.

*Oidium Citri* Bondar, Lab. Path. Veg. Bahia Bol. **7**: 78, fig. 36b. 1929, nomen nudum.

*Corticium microsclerotia* Weber, Phytopath. **29**: 565. fig. 4, 7. 1939, nomen nudum.

FIGURE 11.

Fructification forming a delicate separable, flaky or thin-hypochnoid pellicle, when dry white to buffy, or semitranslucent; hyphae branching at right angles and with some cruciform cells, without clamps, 4.5–14 (–17) $\mu$ in diameter, the basal long-celled and often somewhat colored, the subbasidial colorless, short-celled, with often barrel-shaped segments, branching abundantly and bearing the basidia in small imperfectly symmetrical cymes; basidia subcylindric and barrel-shaped (widest toward the middle) or obpyriform or clavate (widest at the summit), (10–) 12–18 (–23) x 8–11 (–12.5) $\mu$, bearing 4 sterigmata which

arise as blunt knobs and become later horn-shaped, (3–) 5.5–12 (–20) x 1.5–3.5 (–4.5) $\mu$; spores ellipsoid or oblong-ellipsoid, thin-walled, flattened on the inside, a little the broadest below the middle, truncate-apiculate, 7–12.5 x 4–7 $\mu$, occasionally germinating by a stout promycelium on which is borne a similar secondary spore.

On surface of living leaves or stems of *Boerhavia erecta, Chimaphila maculata,* "sour orange seedlings" (*? Citrus Aurantium*), *C. grandis* c. Marsh, *C. sinensis* c. Bahia, *Dianthus Caryophyllus, Ficus Carica, Hydrophyllum virginicum, Nicotiana tabacum, Solanum Dulcamara, S. tuberosum,* and an indeterminate member of the Amaryllidaceae.

Specimens examined: Denmark, Lyngby, Sjaelland, VI.21.10, *J. Lind,* as *H. Solani* (FH); Brazil, *Bondar* (SP *725*) and *Fawcett & Bitancourt* (SP *2499, 2516*), all as *C. areolatum;* Argentina, *Fawcett & Bitancourt* (SP *2632*), as *C. areolatum;* Ecuador, *de Lagerheim,* **type** and paratype of *H. filamentosus* Pat.; Panama, *Fawcett* (*SA 149*); Nova Scotia (OTB *10326*); Florida, Gainesville, IX.10.41, *Weber,* as *C. microsclerotia*; also specimens from Ontario, Maine, Massachusetts, New York, and Iowa.

Distinguishable from the saprobic species by the flattened-ellipsoid spores with a peculiar truncate, almost jagged, apiculus, by the four usually long and thick sterigmata (or epibasidia; the evidence is not clear), and by the small and usually imperfect cymes of basidia. The spores of *P. flavescens,* which in some respects approaches the present species, are subglobose or have a subglobose body with apical prolongation, and the basidiocarp is usually much thicker and more hypochnoid. Obviously the substratum — parts of living plants, or occasionally soil in contact with them — is the easiest identifying character, and it seems to be a reliable one; during the present study of a large amount of saprobic material no specimen has been encountered on another substratum which could be taken for *P. filamentosa,* nor have the typically saprobic species ever been seen on living plant-parts. Leaving aside the matter of substratum, however, the present species is readily distinguishable, as noted, by morphology alone.

The diseases associated with the various fungus names here listed in synonymy seem distinct enough, but the fungi, at least in the material at hand, show relatively slight variation. *C. areolatum* is the smallest of the lot, with spores 7.5–9 x 4.5–5 $\mu$, and correspondingly small hyphae and basidia (fig. 11 e–g); the sterigmata, as throughout the present species, are enormously variable within a single collection, and mature ones run from 5.5 to 10 $\mu$ in length and about 2.5 (or in other specimens only 1–1.5) $\mu$ in diameter, in contrast to the very large ones shown by Stahel's material (l. c.). A specimen forming a mildew-like growth on sour-orange seedlings (from Panama), with no suggestion of the areolate leaf-spot, is indistinguishable, as is a Massachusetts specimen on *Chimaphila. Corticium microclerotia* (fig. 11 h–i) shows spores 8.5–9.5 x 5 $\mu$, and small basidia and long sterigmata (7–9 x 1.5–2 $\mu$) similiar to those of *C. areolatum.* The type specimen of *H. filamentosus* lies near the upper end of the size-range; it is quite indistinguishable from material

examined growing on potato (fig. 11 a–d). *Corticium praticola* Kotila, the species next discussed (q. v.) may belong with it. The similarity of *H. filamentosus* and *H. Solani* would seem sufficiently apparent from the illustrations, published (ll. cc.) in successive numbers of the same journal; it is a wonder that Prillieux & Delacroix's account was ever allowed to appear, and a greater wonder that their name was not at once reduced to synonymy. Differences in presence or absence of sclerotia, and, *a fortiori*, in time or place of their formation, or in their size, must be regarded as untrustworthy — at least, until comparative studies have been further carried out. Among mycelia isolated from the pathologically highly uniform and characteristic areolate leaf-spot of *Citrus*, Stahel (l. c.) found some which formed sclerotia readily and others which would under no conditions do so.

The sclerotial stage of *P. filamentosa* has been described under the names *Rhizoctonia Solani* Kuhn, Krankh. Kulturgew. 224. 1858, and *R. microsclerotia* Matz, Phytopath. **7:** 116. fig. 3; pl. 2. 1917. The description of *Corticium microsclerotia* refers to that of *Rhizoctonia microsclerotia;* but the earlier description, dealing with only the imperfect stage, cannot form the basis for a basidiomycetous species. Since the account of *C. microsclerotia* lacks the validating Latin diagnosis, Weber's name must technically be accounted a nomen nudum. *Corticium areolatum* Stahel is also invalidated, by the existence of the earlier homonymous species of Bresadola. Bondar's figure of *Oidium Citri* probably represents the present fungus (as suggested by Stahel), and Bondar's material probably included basidia; but since the fungus is not described by Bondar (l. c.), his name has no standing.

There is room for further study of the fungi here treated; obviously a great deal more is known of the diseases produced by *P. filamentosa* than about the fungus itself. It is at least arguable that on different hosts and under different circumstances a single pathogen may give rise to different pathological phenomena. It would appear preferable, then, to maintain whatever differentiating terminology is needed for the various diseases, but to admit taxonomic segregation within the pathogen only when significant differences have been shown to exist between groups of the fungi themselves. Further study may demonstrate such differences, and the necessity of subdividing *P. filamentosa;* they have not thus far been shown, nor has the present study revealed them.

Since most of the literature concerning "*C. vagum*" and *H. Solani* as a parasite is concerned with the host rather than with the fungus, it has not been cited here.

## SPECIES INQUIRENDAE

15. **Corticium praticola** Kotila, Phytopath. **19:** 1065. fig. 5, 6. 1929.

"Hymenium loose, in minute placques formed by a more or less dichotomous branching of the vegetative hyphae. Terminal cells develop

into basidia bearing 1 to 4 sterigmata, the usual number being 3. Basidia average 15.6 μ long and 6.5 μ wide. Sterigmata vary from 13 to 26.5 or more μ long, average 18.8 μ, and taper gradually upward from point of attachment to basidium, greatest diameter 2.6 μ. Basidiospores hyaline, ovate, apiculate, smooth-wall, from 5.2 to 7.8 μ long and from 4.9 to 5.5 μ wide, with average dimensions of 7.7 by 5.2 μ." — Kotila, l. c.

A parasitic form characterized by, among other things, extremely long sterigmata (? epibasidia) and spores germinating by repetition. Like similar material of *P. filamentosa* (from which it is not certainly distinguishable), and like *P. flavescens*, it might be included in either *Pellicularia* or *Ceratobasidium* — in the former because of clear affinity, in the latter by definition. The fungus was made the subject of intensive study by Kotila; after examination of an excellently preserved portion of his type material I find nothing to add to either his description or his illustrations (l. c.). Because that material grew in a Petri dish, it is not wholly comparable with specimens — e. g., of *P. filamentosa* — collected in the field. Because the abundant basidia and spores now present in it are now tightly stuck to the Petri dish cover, it seems possible that their development was modified by water condensed there. I therefore prefer to suspend judgment on the problems of its generic position and its relation to *P. filamentosa*.

16. **Corticium album** Dastur, Indian Jour. Agr. Sc. **10**: 92. pl. 1. 1940, nomen nudum.

From the plate cited and from two slides of the type it appears highly probable that this fungus is a member of the genus *Pellicularia*. The basidia are longer than in most species of the genus and apparently distinctly clavate, in both characters resembling those of *P. flavescens*. Neither the figures, however, nor the sections provide a sufficient basis for redescription or safe disposition of the fungus. As pointed out by Mundkur (Current Sc. **9**: 284. 1940), Dastur's name is a later homonym of *C. album* Britz., Bot. Centr. **71**: 91. 1897 — or would be except that it lacks a Latin diagnosis, and hence was never validly published.

## SPECIES EXCLUDENDAE

Four species included by Bourdot & Galzin in *Corticium* sect. *Botryodea* are here excluded from *Pellicularia:*

**C. sterigmaticum** Bourd. = *Ceratobasidium sterigmaticum* (Bourd.) Rogers, Univ. Iowa St. N. H. **17**: 7. 1935.

**C. cornigerum** Bourd. = *Ceratobasidium cornigerum* (Bourd.) Rogers, Univ. Iowa St. N. H. **17**: 5. 1935.

**C. terrigenum** Bres. is probably likewise a *Ceratobasidium:* since no one appears to have seen it since Bresadola, judgment must be suspended.

**Hypochnella violacea** (Auersw. in sched.) Schroet. has much in common with *Pellicularia* and also, as pointed out by Martin (Iowa Ac. Sc. Trans. **44**: 47. [1938].) with *Coniophora*. At least until a comparative study can be made of species of the latter genus, it seems best not to include it in *Pellicularia*.

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**Fig. 1–6.** **1,** *Pellicularia chordulata:* a–c, type; d–f, DPR *948*. **2,** *P. asperula:* type. **3.** *P. Langloisii:* Thaxter *57*. **4,** *P. cystidiata:* type. **5,** *P. ochroleuca:* DPR *702* (Massachusetts). **6,** ***P. ansosa:*** **type.**

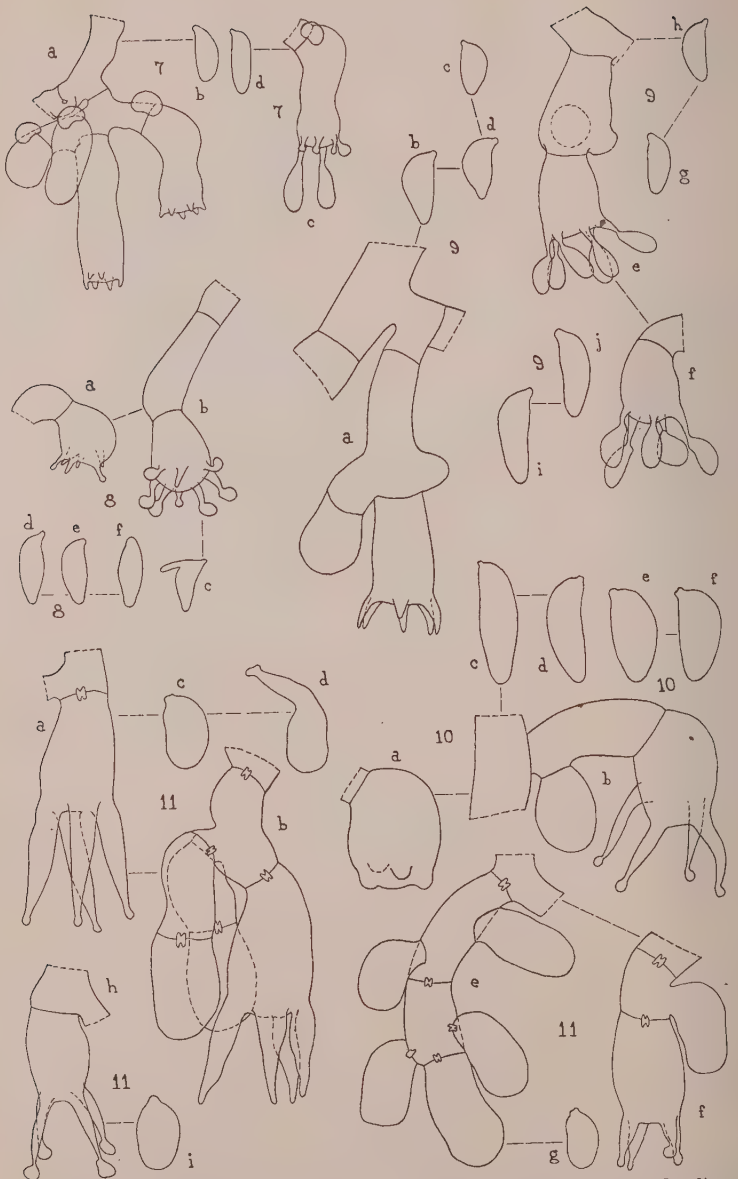


**Fig. 7–11.** **7,** *Pellicularia subcoronata:* a–b. DPR *990* (Rhode Island); c–d, DPR *989* (Massachusetts). **8,** *P. lembospora:* a–c, type; d–f, DHL *567*. **9,** *P. vaga:* a–d, type of *C. botryosum;* e–h, DPR *988* (Rhode Island); i–j, DPR *987* (Oregon). **10,** *P. Koleroga:* a–d, Thomas; e–f, Reimer. **11.** *P. filamentosa:* a–d, OTB *10326;* e–g, SP *725;* h–i, Weber.

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# SEVERAL FUNGICOLOUS FUNGI[1]

Edgar V. Seeler, Jr.

A small discoid parasite on *Trichoglossum* collected by the author proved to be *Hypomyces Geoglossi* Ell. & Ev. which had been transferred later to *Eleutheromyces*. Examination of authentic specimens uncovered the confusion in herbaria and in the literature concerning it and an associated group of species which grow on living or on decaying fungi. From a study of a few of these species have come these notes. Included are the following: a discussion and emendation of the genus *Eleutheromyces* and a redescription of its type species, a redescription from the type of *Eleutheromycella mycophila* von Höhnel, the first full description of *Sphaeronema blepharistoma* Berk. and the establishing of it by priority as the type of *Hyalopycnis* von Höhnel, the erection of the new genus *Micropyxis* based on *Hypomyces Geoglossi* Ell. & Ev., and finally an emendation of *Sphaeronaemella* Karsten and of its type species *S. Helvellae*. All species discussed have been illustrated as completely as possible by camera lucida drawings. Abbreviations of herbarium names are those recommended by Lanjouw in Chronica Botanica **5**: 142–150. 1939. Citations pertinent to synonymy and discussion are listed below each name considered.

**ELEUTHEROMYCES** Fuckel. Symb. Myc. p. 183, pl. 4, fig. 52a–c. 1869.

Fuckel based this genus on *Sphaeronema subulatum* Fries which he stated was an Ascomycete with *Isaria brachiata* Schüm. as its conidial phase. The type, or cotype, was therefore Fries' collection distributed as Scler. Suec. *325*, and authentic material for the genus concept (determined by Fuckel) comprised Fungi Rhenani *773*.

There should have been no confusion as long as these specimens existed for study and the writer can state with certainty that the fungus which carried the name of *Sphaeronema subulatum* is not an Ascomycete but a member of the Sphaeropsidales. It may prove to have an ascophorous form, but none has appeared in the five collections from Europe and thirteen from North America examined here. It should be pointed out that all who claim to have seen asci have recorded the ciliate spores (typical pycnospores) but have completely failed to record or recognize any method other than asci for bearing these spores. While there have been no asci ever observed in the present study there have been the same pycnophores (Pl. 1, fig. 2) clearly visible with spores attached in every fructification examined. Perhaps the fact that Fuckel, and those who later "saw" asci, entirely missed these ever-present pycnophores is the most important evidence that, after Fuckel, they were playing follow the leader. Each case will be considered in detail. Citations will be found with the list of synonyms under the species *E. subulatus*.

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 220.

Fuckel was the first to report asci "52 x 2.5 mic." and he illustrated one with a tiny sketch showing eight simple oval spores arranged in a single row, and in his fig. b a single "endospore" is shown as biterminally ciliate. He gave *Isaria brachiata Schum.* as the conidial phase and described its conidia as "ciliate at both ends or nude." Conidia from Fuckel's collection (sub *E. subulatus*) ex herb. Barbey-Boissier (FH) are typical and are never ciliate. The other Fuckel specimen examined, Fungi rhenani *773* (FH), exhibits the following fungi: *Sphaeronema subulatum* Fr., *Cryptophaeella Heteropatellae* von Höhnel, and *Isaria brachiata* Schüm. In 1892 Ellis devoted six figures to this species which are the clearest illustrations to date; they all represent *Sphaeronema subulatum* Fr. except for the fact that he has drawn a heavy black line around eight appendiculate spores, the "mature ascus," and he has shown "peculiarly jointed paraphyses." These "paraphyses" are typical pycnophores of *S. subulatum* Fr., a fact which Ellis obviously did not recognize; and his "ascus" being surrounded with them as depicted would indicate that asci grow among pycnophores. Specimens collected and determined by Ellis as *Eleuth. subulatus* have revealed no asci since Ellis saw them, and all are typical *S. subulatum* Fr. Saccardo (1879) reported: asci 8-spored, 50 x 4 $\mu$, spores 2-rowed, 5–6 x 1.75–2.5 $\mu$, often associated with *Isaria brachiata;* the specimen was from Italy, collected by Spegazzini. In 1883 Saccardo added the measurements: perithecia 1.5 mm. high x 0.3 mm. broad, asci 48–52 x 2.5-3 $\mu$, spores "submonostichus," 4–6 x 1.5 $\mu$. In a section of Rabh. Krypt. Fl. published the next year, 1884, Winter copied Saccardo's data and Fuckel's drawing. Later (1905) as a rebuttal to von Höhnel, Saccardo quoted himself as having seen asci in 1879; and in 1913, still answering von Höhnel, he refers to "Winter, Schröter, Ell. & Ev., etc." as evidence for the ascus; here he suggests the possibility of separate perithecial and pycnidial forms — whereas Ellis' picture would indicate both in one. Jaczewski in his monograph of *Sphaeronema* passed this species easily saying, "the asci are so ephemeral that one never finds them in old specimens, but the form of the spores is so characteristic as not to permit error." Seaver (1909) saw and drew the ciliate spores and assumed that they came from asci as he noticed no other source. In combatting this ascus theory, it should again be emphasized that no one of the men who described asci has mentioned the important feature so conspicuous in his own specimens, pycnophores bearing spores.

On the other side of the ledger, there are those who have searched carefully for asci and failed to find them in authentic specimens left us as evidence for the writings of earlier workers. These include: von Höhnel (1902), Petrak and Sydow (1923), Petch (1935), and Grove (1937). Von Höhnel and Petrak and Sydow saw the pycnophores and said definitely that they thought that the ascus phase did not occur as it had been described. And Petch (Shear to the contrary notwithstand-

ing) hesitated to believe that Fuckel's ascigerous form existed. The present author's findings are discussed under the type species *Eleuth. subulatus.*

Finally there are Shear's most recent (1940) and convincing arguments for the retention of *Eleutheromyces* as an Ascomycete genus. These are based entirely on the literature, since Shear himself states that his packet of the cotype, Scler. Suec. *325,* contained "no fructifications of a *Sphaeronaema,*" and he does not mention having examined any other specimens, not even Fungi rhenani *773* which Fuckel distributed.

It is hoped that from the above it has been shown that modern experimental evidence taken from authentic specimens from two continents has failed to support the presence of asci in this species. Petrak and Sydow have given what the writer believes to be the correct interpretation of the situation: (translating from their German) "The circumstance that several authors claim to have found asci of this fungus and also have pictured such may easily be explained by the fact that the conidia, strongly glued together by slime, hang together in shorter or longer rows, often more or less parallel to each other. Such rows of spores were probably regarded as asci."

Petrak and Sydow, and Shear have shown that *Sphaeronaema* should be reserved for the black sphaeropsidaceous forms based on *S. cylindricum* (Tode) Fr., and should not include nectrioidaceous species. Grove's 1937 combination is no longer tenable because Karsten's *Sphaeronaemella* had for its type *S. Helvellae* which is here shown to be an Ascomycete. The von Höhnel genus *Eleutheromycella* seems related but as shown elsewhere in this paper must remain distinct generically according to present keys and systems of classification which are based on pycnidial color. Therefore since *Eleutheromyces* as an Ascomycete was based on confusion and misinterpretation of two unrelated Fungi Imperfecti, and yet since the name is firmly associated in the literature and in herbaria with its type, *Sphaeronema subulatum* Fr., and as the name does suggest the apparent relationship to *Eleutheromycella* von Höhnel, I propose to emend it as follows:

**ELEUTHEROMYCES** Fuckel, emend. Seeler.

(Sphaeropsidales, Nectrioidaceae)

Pycnidia single, superficial, light-colored, soft-leathery or gelatinous and translucent when wet, walls and neck pseudoparenchymatous, conoid with upper portion more or less extended into a tapering neck, internally lined up to the mouth with simple or more often branched hyaline conidiophores. Spores hyaline, typically one-celled and ellipsoid, apically ciliate, basally attenuate.

Type species: *Eleutheromyces subulatus* (Fr.) Fuckel, emend. Seeler.

Of the two other species which have been placed in this genus, the first, *E. longisporus* Phill. & Plowr. (Grevillea **13:** 78. 1885) has been

transferred to *Rhynchonectria* by von Höhnel (Sitzb. Akad. Wiss. Wien **111**: 1023. 1902) and has been carefully described and illustrated by Grove (Journ. Bot. (London) **45**: 171, pl. 485, fig. 3a–e. 1907). The second, *E. Geoglossi* (E. & E.) Seaver is discussed elsewhere in this paper under *Micropyxis*.

**Eleutheromyces subulatus** (Fr.) Fuckel, emend. Seeler.

? *Sphaeria subulata* Tode, Fungi Mecklenb. **2**: 40, pl. 15, fig. 117a–e. 1791.
*Sphaeronema subulatum* Fries, Syst. Myc. **2**: 536. 1822. — Petrak & Sydow, Ann. Mycol. **21**: 361. 1923. — Shear, Mycologia **32**: 541–544. 1940.
*Sphaeromyxa subulatum* (Fr.) Sprengel, in Linn. Syst. Veg. (16 ed.) **4**: 406. 1827.
*Zythia subulata* (Fr.) Schweinitz, Syn. Fung. Amer. Bor. p. 247, no. 2128. 1832.
*Zythia compressa* Schweinitz, Syn. Fung. Amer. Bor. p. 247, no. 2130. 1832.
*Sphaeronema oxyspora* Berkeley, "Decades of Fungi no. 136," Journ. Bot. (London) **6**: 325. 1847.
*Eleutheromyces subulatus* (Fr.) Fuckel, Symb. Mycol. p. 183. 1869. — Sacc., Michelia **1**: 50. 1879; Syll. Fung. **2**: 455. 1883; **17**: 779, 1905; **22**: 1142, 1913. — Winter, in Rabh. Krypt. Fl. **2**: 93, 4 fig. p. 84. 1884. — Ell. & Ev., N. Amer. Pyren. p. 93, pl. 14, fig. 6–12. 1892. — Jaczewski, "Monographie du genre Sphaeronema Fr.", Nouv. Mem. Soc. Imp. Nat. Moscou **15**: 336. 1898. — von Höhnel, "Fragm. Myk. no. 32," Sitzb. Akad. Wiss. Wien **111**: 1022. 1902. — Seaver. Mycologia **1**: 47, pl. 4, fig. 12–13. 1909. — Petch, Journ. Bot (London) **73**: 186. 1935. — Shear, Mycologia **32**: 546. 1940.
*Sphaeronaemella oxyspora* (Berk.) Saccardo, Syll. Fung. **3**: 618. 1884.
*Sphaeronaemella subulata* (Fr.) Grove, Brit. Stem & Leaf Fungi **2**: 115–116, fig. 54a–c. 1937.

PLATE I, FIG. 1–6.

Pycnidia discrete, clustered or scattered, when dry brittle and approximately "Raw Sienna" (Ridgway Pl. III), when wet translucent and gelatinous, often with flecks or threads of dark brown on the basal portion, extremely variable in size and shape, diameter of base 130–350 $\mu$, over-all height 220–3300 $\mu$, essentially conical, usually tapering gradually upward, walls pseudoparenchymic of thick-walled polygonal cells up to the ostiole which is fimbriate but usually hidden in a globular mass of spores or entirely broken away. Spores borne on fine long sterigmata which are drawn out from the apex or just below the nodes of hyaline, simple or branched, septate conidiophores (1.5–3.5 $\mu$ diam.) which completely line the pycnidial cavity and neck canal. Spores not catenate, hyaline, one-celled, ellipsoid body (4–5.5 x 1.5–2 $\mu$) with attenuated filiform pedicel (2–3 x 0.5 $\mu$) and apical seta (3–7 x 0.5 $\mu$).

Growing on various decaying agarics, boletes, polypores, and other fleshy Basidiomycetes. Recorded range: North America; England to eastern Russia; Italy to Scandinavia.

Type: Some specimens of Scleromyceti Sueciae *325* distributed by Fries as seen by Petrak and Sydow (l. c.). This was a mixed collection apparently, as the specimen in the Farlow Herbarium shows only *Didymostilbe* sp., and yet the specimens examined prove that there is a well-founded international concurrence in the concept of this common species.

Specimens examined: (all in FH unless otherwise indicated) ONTARIO, *Cain*, TRT *4859;* NEW HAMPSHIRE, Shelburne, *Farlow.* — Chocorua, on *Polyporus betulinus*, Sept. 1906, *Farlow.* — Chocorua, on *Lenzites sp.*, Aug. 1913, *Farlow.* — VERMONT, L. Dunmore, Sept. 1896, *Farlow;* MASSACHUSETTS. Newton, Oct. 1878, *Farlow.* — Waltham, Nov. 1885, *Thaxter;* CONNECTICUT, New Haven, Sept. 1888, *Thaxter;* PENNSYLVANIA, ex herb. *Schweinitz* in herb. Curtis *2128.* — Bethlehem, on *Polyporus frondosus*, type (?) of *Zythia compressa* Schw., ex herb. Schw. in herb. Curtis; OHIO, type (?) of *Sphn. oxyspora* Berk., in herb. Curtis. — Chillicothe, Aug. 1906, *Kellerman*, det. Peck (CU 21356); SOUTH CAROLINA, Soc. Hill, Dec., in herb. Curtis; FINLAND, *Karsten*, Fungi Fenn. *370;* GERMANY, *Klotsch*, Herb. Viv. Myc. *1463.* — *Fuckel*, Fungi Rhen. *773.* — *Fuckel*, ex herb. Barbey-Boissier. — *Rabenhorst*, Fungi Eur. *1334.*

In order to bring together all pertinent information, this species has been illustrated and redescribed here. Among the listed synonyms Tode's name is marked "?" even though Fries credited the species to him. Since Tode's specimen is no longer available for comparison, it is impossible to be certain today what fungus he meant.

**Eleutheromycella mycophila** von Höhnel, Frag. Myk. nr. 178, Sitzb. Akad. Wiss. Wien, etc. **117:** 1023. 1908. — Grove, Brit. Stem and Leaf Fungi **2:** 116. 1937. — Shear, Mycologia **32:** 546. 1940.

*Eleutheris*, Clements & Shear, Genera of Fungi, p. 371. 1931 (arbitrary change of name).

PLATE I, FIG. 11–15.

Pycnidia single, parasitic (?), fungicole, submerged or erumpent, black, smooth, soft-leathery when wet, spherical or deformed by position of growth in host, those growing in pores being elongated, those under the tough epidermis being flattened, body in vertical section 250–900 $\mu$ wide x 300–510 $\mu$ high, wall completely pseudoparenchymatous of thin-walled cells, neck from short-papillate to 150 $\mu$ long and tubular (only 5 pycnidia measured), ostiole not fimbriate. Spores borne on fine, long sterigmata which are drawn out from the apices or from just below the nodes of hyaline, simple or branched, septate conidiophores (1.2–2.5 $\mu$ diam. at base) which completely line the pycnidial cavity. Spores not catenate, hyaline, typically one-celled, cylindrical-ellipsoid body 5–6.5 (–10) x 1.2–1.5 $\mu$, with attenuated filiform pedicel 2–3 $\mu$ long and an apical seta 12–30 x 0.5 $\mu$.

Growing, apparently parasitically, in sporophores of *Polystictus versicolor* (L.) Fr.; pycnidia growing in pores of the host open downwards, those embedded in trama open upwards with necks protruding through the surface.

Type: Herb. v. Höhnel sheet *10203* (FH-H), Georgenberg, Purkersdorf, Wiener-Wald, Austria, Aug. 2, 1907, collected by *von Höhnel.*

This is known only from the type specimen which is also the type of the genus. It is strikingly like *Eleutheromyces subulatus* emend. in the character of spores and conidiophores but differs from it in the black, short pycnidia and the longer more slender spores. It is hoped that the figures and this description from the type will eliminate some confusion evident in the literature.

**Hyalopycnis blepharistoma** (Berk.) Seeler, comb. nov.

*Sphaeronema blepharistoma* Berkeley, "Notices of British Fungi no. 57" in Mag. Zool. and Bot. **1**: 512. 1837. — "Not. Brit. Fungi nr. 196" in Ann. Mag. Nat. Hist. **6**: 363. 1841.

*Hyalopycnis vitrea* von Höhnel (non Corda?), Hedwigia **60**: 151–154. 1918.

*Hyalopycnis hyalina* v. H., Hedwigia **60**: 151–154. 1918.

PLATE I, FIG. 7–10.

Pycnidia usually growing fairly close together, when dry pale yellowish, transparent, "glassy," amber, often collapsed on one another in a confused tangle cemented by the spores, rarely standing singly with erect necks; when wet nearly hyaline with milky opaque spore-mass within, soft-gelatinous, size and shape variable (300–600 $\mu$ over-all height), a short, broad basal trunk below the swollen body (100–200 $\mu$ diam.), tapering gradually into the neck (30–70 $\mu$ diam.) and flaring again at the plume-like apex by the out-curving of the two or three ranks of delicate, parallel, scarcely-septate filaments which make up the perithecial wall and neck. Pycnospores one-celled, hyaline (yellow-amber in mass), thin-walled, generally ovoid but very irregular in shape and size (5–) 9–13 (–18) x (3–) 3.5–5.5 (–7) $\mu$, occasionally budding repeatedly at the same point and thus forming cruciform clusters of cells, or later their contents "encysting" as thick-walled chlamydospores about two-thirds the length and the same diameter as the parent spore. Pycnophores arising from the central loosely plectenchymic base of the pycnidial cavity, dendroidally branched, producing spores acrogenously.

Substrata: *Russula adustus, Lactarius pargamenus, Limacium penarium, Pleurotus* sp., and indet. agarics. — *Leotia lubrica* — "nettle roots" (*Urtica*), carrot (*Daucus*); all of these somewhat decayed when found. Whetzel (in litt.) says that it grew easily in culture on several media including bean stems, various fleshy fungi, and agar media.

Type: on blackened *Ag.* (*Russula*) *adustus*, King's Cliffe, England, Sept. 1836, collected by *M. A. Berkeley.*

Lectotype: on decaying *Russula* or *Lactarius*, Aug. 1917, Chocorua, New Hampshire, U. S. A., coll. & det. *W. G. Farlow.* Parts of this specimen (FH) will be distributed to the herbaria of the following institutions: Mycology and Disease Survey of the U. S. Dept. Agr., New York Botanical Garden, University of Michigan, Kew Botanical Garden.

Specimens examined: NEW HAMPSHIRE, Chocorua, on agaric, Sept. 14, 1907. coll. & det. as *Sphaeronema vitreum* by *Farlow.* — Chocorua, on *Russula* or *Lactarius*, 1917, *Farlow;* MASSACHUSETTS, Cambridge, on carrot, Feb. 19, 1890, *Farlow.* (FH slide 1642); NEW YORK, Enfield Gorge near Ithaca, on *Leotia lubrica*, Aug. 14, 1942, *Whetzel*, (CU 31538) — Richford, culture on sporophore of *Favolus europaeus* original isolate from decaying *Pleurotus* sp. with *Hypomyces* sp., Aug. 14, 1904, *Whetzel* (CU 2022); ENGLAND, King's Cliffe, on blackened *Ag.* (*Russula*) *adustus*, Sept., *Sphaeronema blepharistoma* Berk., Berkeley's British Fungi, Fasc. III, nr. *189* **(cotype)** — also a duplicate of the last, and a slide made from it by von Höhnel; AUSTRIA, Wiener Wald, on decaying *Limacium penarium*, Sept. 16, 1903, *von Höhnel*, (FH-H 10202) — Wiener Wald, on *Lactarius pargamenus*, Aug. 21, 1906, *von Höhnel*, (FH-H 10200); BOHEMIA, near Flana, on agaric, Aug. 12, 1905, *Bubak*, (FH-H 10202).

No one has recorded having seen Corda's specimen of *Sphn. vitrea.* His description has three differences from that of the present species. First, he says that the "mature spore, seen from the side, is egg-shaped and at the same time four-edged" the latter probably meaning in cross-section; second, he pictures the spores as very uniform in size and having thick walls; third, his enlarged view of the pycnidial mouth does not show the wide-flaring pointed hyphae so characteristic for *H. blepharistoma.* All three differences can be explained by saying: one, Corda observed plasmolized, shrunken pycnospores; two, he illustrated chlamydospores after the pycnospore wall had dissolved; three, his close-up of the beak is of a very young pycnidium. All of these are begging the point, however, and are speculative theories as Corda's specimen may well have been something else entirely, perhaps an Ascomycete.

To point out the fallacy in such speculation one needs only refer to von Höhnel (l. c.) where he calls a fungus of his own collection *Sphn. vitreum* Cda. without comparing Corda's type and then establishes *Hyalopycnis vitrea* on this (v. H.) specimen as genotype. He says it differs from *Sphn. blepharistoma* Berk., though Berkeley (1841) became equally convinced that *Sphn. blepharistoma* was synonymous with Corda's fungus. Unfortunately von Höhnel labelled the four packets in his herbarium "*Sph'nmella*" with the species name followed by "?" and never indicated the genus "*Hyalopycnis*" on them or noted which he considered as *H. vitrea* or *H. hyalina.* Slight variations in size of pycnidia or spores seem to have been his species criteria, and these have no significant value in this case. At any rate, all of von Höhnel's specimens represent the same species, so both his species names are here subjected to Berkeley's prior *blepharistoma,* specimens of which have proved to be the same thing. The five American collections, which have not been recorded heretofore, are indistinguishable from the European.

Until Corda's type specimen is found and examined, for the present it seems best to use Berkeley's name which was published the same year as Corda's, 1837, and which has an exsiccati set to substantiate it. Since von Höhnel's specimens on which *Hyalopycnis* was based are really later collections of *Sphn. blepharistoma* Berk. it is proposed that Berkeley's species be the type of the genus *Hyalopycnis* v. H.

Listed here as doubtful is *Sphæronema vitreum* Corda, Icon. Fung. **1:** 25, pl. 7, fig. 297. 1837, with the combinations *Ceratostoma vitreum* (Cda.) Fries, Summa. Veg. Scand. p. 396. 1849 and *Melanospora vitrea* (Cda.) Sacc., Syll. Fung. **2:** 463. 1883.

**MICROPYXIS** Seeler, gen. nov.

(Discomycetes, Pezizales)

Ascomata sessilia in subiculo tenuo; parvissima, gelatinosa; excipulo hypharum parallelarum; paraphysibus distinctis, infra ramosis non epithecio formantibus; ascis breve-clavatis, sursum obtuse rotundatis, 8-sporis; sporis elongato-ellipsoideis vel basem leniter attenuatis, hyalinis, 1- vel 2-cellulatis.

Ascocarp sessile on a thin subiculum, very reduced and small, gelatinous; excipulum composed of parallel hyphae; hymenial elements surrounded and covered by gelatinous material; paraphyses distinct, branched below, not forming an epithecium; asci short-clavate, bluntly rounded above, 8-spored; spores elongate-elliptical or tapered slightly toward the base, hyaline, 1- or 2-celled.

Differs from other genera in the button-like hypothecium combined with an entirely filamentous-gelatinous excipulum and the absence of any true epithecium. It probably belongs below the most reduced members of the Helotiaceae sensu Keissler in Rabenhorst's Krypt. Flora **8:** 52. 1930. Beside the absence of any perithecial wall, the shape of the asci and spores and the presence of true paraphyses exclude it from the Hypocreales.

Type species: *Micropyxis Geoglossi* (Ell. & Ev.) Seeler.

**Micropyxis Geoglossi** (Ell. & Ev.) Seeler, comb. nov.

*Hypomyces Geoglossi* Ellis & Everhart, Journ. Myc. **2:** 73. 1886. — Journ. Myc. **3:** 114. 1887 [revised description] — N. Amer. Pyreno. p. 72. 1892.
*Peckiella Geoglossi* (Ell. & Ev.) Saccardo, Syll. Fung. **9:** 944. 1891.
*Eleutheromyces Geoglossi* (Ell. & Ev.) Seaver, Mycologia **1:** 48. pl. IV, fig. 10-11. 1909 — N. Amer. Flora **3:** 5. 1910.

PLATE II, FIG. 1–7.

Ascocarps superficial, parasitic on hymenial surface of members of the Geoglossaceae, growing close together, mostly distinct, rarely anastomosing, pale yellow-brown, translucent and gelatinous when wet, shrunken and brittle when dry, resembling microscopic droplets of dark resin, at first spherical, finally up to three times as broad as high, 60–150 $\mu$ diam. x 60–70 $\mu$ high, ascus layer 25–45 $\mu$ deep; base (hypothecium) short, of thick-walled gelatinous hyphae, pseudoparenchymatous, lower part composed of hyphae which spread out, surrounding the tops of host paraphyses and asci and wedging between them and connecting to the bases of neighboring apothecia; excipulum formed of a single layer of branching filaments in an amber-colored gelatinous substance; these arch over the tops of the asci in young apothecia almost completely covering them; no true epithecium of fused tips of paraphyses; pale amber gelatinous material covers the tops of the asci. Asci eight-spored, clavate, short-stiped, stipes mostly broad, thickened, obtuse apex, 28–45 x 6.4–8.3 $\mu$ rarely a little longer. Paraphyses hyaline, filamentous, simple or once-branched near base, 1.2–1.6 $\mu$ diam., tips never branched, swollen, 1.9–3.2 $\mu$ diam., slightly overtopping the asci and about as numerous as they. Spores one-celled, hyaline, long elliptical or tapering toward base, ends rounded, irregularly distichous, 7.7–10.5 x 2.5–3.2 $\mu$. No parts blue with iodine.

Type: on *Geoglossum (glabrum?)*, [= *Trichoglossum Farlowi* (Cke.) Dur.], Newfield, New Jersey, collected by *J. B. Ellis,* Sept. 1876.

Specimens examined: (all on *Trichoglossum Farlowi* except the first, all FH.) MASSACHUSETTS, Nantucket, on *Trichoglossum Walteri* (Berk.) Dur., Oct. 10, 1911, and on *T. Farlowi*, Aug. 1938 and Sept. 1941, *Seeler;* NEW JERSEY, Newfield, "on *Geoglossum (glabrum)*?". Sept. 1879, ex herb. *Ellis*, authentic (FH), and Aug. 7, 1887, *Ellis*, authentic (FH-E); TENNESSEE, Burbank, "on *Geoglossum*," Aug. 1896, coll. & det. *Thaxter* (FH 677); NORTH CAROLINA, Cranberry, "on *Geoglossum*," Aug. 1896, coll. & det. *Thaxter* (FH 7931).

Since this interesting little fungus grows and matures on living sporophores of *Trichoglossum* it can without doubt be called parasitic. In the fresh and mature condition it can be detected by the smooth brownish tinge the many apothecia give to the usually velvet-black hosts on which it has been found. But after the specimens have been dried, it is impossible to be certain of its presence or absence even with a twenty-power hand-lens. It does not seem to affect its host beyond causing a shrinkage in the normally inflated, curved tips of paraphyses. Several attempts to grow this fungus in culture on potato-dextrose agar and on Trichoglossum-decoction agar have been unsuccessful; ascospores discharged on the agar from fruit bodies fastened above, swelled a little and produced short buds but grew no farther. No evidence has been found for relating this species with any imperfect form: see Howell, Mycologia **31:** 196, 207, 209, Fig. C.8, D.4. 1939 (re *Stephanoma tetracoccum*).

**SPHAERONAEMELLA** Karsten, emend. Seeler.

(Hypocreales, Nectriaceae)

Perithecia light colored, soft, with neck composed of parallel filaments, mouth fimbriate. Asci eight-spored, subspherical, evanescent; paraphyses none; ascospores one-celled, hyaline to pale yellow; differing from *Melanospora* in the hyaline spores. Originally described as belonging in the Sphaeropsidales by Karsten in Hedwigia **23:** 17. 1884, and emended by Grove in Brit. Stem and Leaf Fungi **2:** 115. 1937 to include pycnidial forms with appendaged spores.

Type species: *S. Helvellae* Karsten, emend. Seeler.

**Sphaeronaemella Helvellae** Karsten, emend. Seeler.

*Sphaeria Helvellae* Karsten, Fungi Fenniae exs. *674.* 1867.
*Sphaeronaemella Helvellae* Karsten, Hedwigia **23:** 17. 1884. Diedicke, Krypt. Fl. Brand. **9:** 694. 1914.
*Sphaeronema Helvellae* (Karst.) Jaczewski, "Monographie du genre Sphaeronema Fries," in Nouv. Mem. Soc. Imp. Nat. Moscow **15:** 302, fig. 1. 1898.

PLATE II, FIG. 8–12.

Perithecia superficial or with lower half sunk in host tissue, mostly growing close together but discrete, sometimes with a very thin whitish hyphal subiculum from which grow branched conidiophores bearing apically, hyaline, one-celled, cylindrical conidia, 14–18 (–23) x 3.5–5 $\mu$; when dry yellowish-amber, collapsed with necks erect like fine white bristles topped by small amber spore-balls; when wet 500–850 $\mu$ over-all

height, body nearly spherical 150–200 $\mu$ diam., quite hyaline except for the pale yellowish spores inside. Body wall of tile-like angular cells grading in a short collar into the purely parallel septate-hyphal tissue of the long slender neck which terminates in a mouth fimbriate with obtusely pointed hyphae. Asci sub-cylindrical, eight-spored, soon evanescent; paraphyses none; ascospores, hyaline-yellow, one-celled, walls clearly visible, reniform to oblong, 8.5–10.5 x 4–4.5 (–5) $\mu$.

Type: on "half-dead" *Helvella infula*, Sept. 1867, Mustiala, Finland, collected by *P. A. Karsten.*

Specimens examined: (all on *Helvella infula*) FINLAND, 1867 et 1883, *Karsten*, Fungi Fenn. *674*, **cotype**, (FH); NEW HAMPSHIRE, Shelburne, *W. G. Farlow* (FH); NEW YORK, Adirondack Mts., Sept. 12, 1914, *C. H. Kauffman & E. B. Mains*, det. C. H. K. (MICH); MICHIGAN, Wallace Lake, Aug. 19. 1930, coll. & det. *A. H. Povah*, FP *533* (MICH).

The ephemeral nature of the asci misled Karsten and others into thinking that this, the type of the genus, belonged to the Sphaeropsidales, and several light-colored perithecial species were transferred into *Sphaeronaemella* after the limitation of *Sphaeronaema* to black forms. According to the system of Saccardo there is a place for this genus among the Ascomycetes in the Nectriaceae, differing from *Melanospora* in having "hyaline" spores. The spores in mass are clearly yellow, so that this species could be considered merely as a light spored *Melanspora*, but the author prefers to retain *Sphaeronaemella*, emended, at least until obvious relationships can be recognized with species in the black spored genus.

Recently Professor H. H. Whetzel has been kind enough to send me notes and drawings which he made in 1904 of apparently this species, as details agree in every respect except for slightly smaller spores, "about 7 x 3½ $\mu$." At that time he noted sub-globose, evanescent asci and external conidia. He found his fungus "parasitic" on *Hypomyces* sp. which grew on a decaying *Russula* ?, Enfield Center Glen, Aug. 27, 1904. Unfortunately the specimen has not been found for comparison.

It should be noted that von Höhnel in his Frag. Myk. 58 (Hedwigia **60:** 151. 1919), though unfamiliar with any specimen of it, surmised from the descriptions that *S. Helvellae* was an Ascomycete when he founded the genus *Hyalopycnis* for nectrioidaceous forms.

## EXPLANATION OF PLATE I

All drawings made with the aid of camera lucida.

Fig. 1–6. *Eleutheromyces subulatus* (Fr.) Fuckel, emend. Seeler.

1. Hyphae from margin of ostiole. × 1175.
2. Pycnophores and ciliate pycnospores. × 1175.
3. Surface pattern of pycnidial wall cells. × 550.
4–5. Mature pycnidia drawn in moist condition. Broken line indicates size of spore-ball at apex. × 65.
6. Vertical section through pycnidium. Pycnophores line the entire inside of wall. × 65.

Fig. 7–10. *Hyalopycnis blepharistoma* (Berk.) Seeler.

7. Hyphae from margin of ostiole. × 1175.
8. Pycnophores and pycnospores. × 1175.
9. a. Chlamydospores which form inside of pycnospores whose wall remnants adhere. × 1175.
   b. Cruciform bud-spores from neck canal. × 1175.
10. a. Young pycnidium, ostiole still closed. × 65.
    b. Vertical section of mature pycnidium. Pycnophores grow at base only of cavity. Wall and neck are composed entirely of parallel scarcely septate filaments whose tips are shown in fig. 7. × 65.
    c. Mature pycnidium, drawn in moist condition. × 65.

Fig. 11–15. *Eleutheromycella mycophila* v. Höhnel.

11. Pycnophores and ciliate pycnospores. × 1175.
12. Surface pattern of pycnidial wall cells. × 550.
13. Diagram to show position of pycnidia in sporophore of *Polystictus versicolor*. × 18.
14. Vertical section through pycnidium near upper surface of host. × 65.
15. Vertical section through pycnidium in lower (pore) surface of host. Pycnophores line the entire inside of wall. × 65.

1. Drawn from TRT 4859 (FH). 2a. *Sphaeronema oxyspora* Berk. cotype in Herb. Curtis. 2b. Klotsch, Herb. Viv. Myc. *1463* (FH). 2c. Soc. Hill, S. C. in Herb. Curtis. 3. TRT 4859. 4. Shelburne, N. H., *Farlow*. 5. Fungi Rhenani *773* (FH). 6. TRT 4859. 7–10. Chocorua, N. H., 1917, *Farlow;* except pycnidia which are from cotype of *Sphaeronema blepharistoma* Berk., Brit. Fungi *189* (FH). 11–15. Type in Herb *v. Höhnel.*

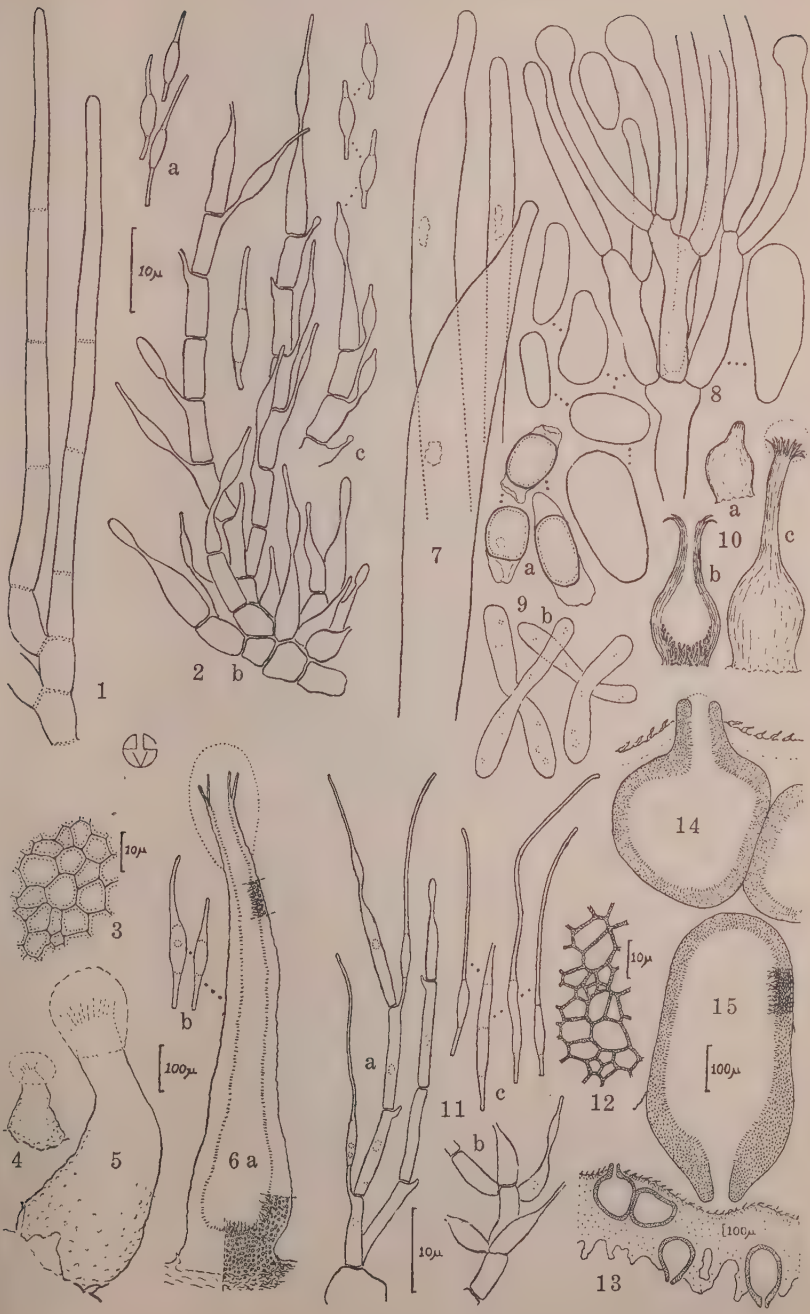
1
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PLATE 1

## EXPLANATION OF PLATE II

All drawings made with the aid of camera lucida.

Fig. 1–7. *Micropyxis Geoglossi* (Ell. & Ev.) Seeler.

1. Stages in the development of asci. × 1175.
2. Two mature asci. × 1175.
3. Eight mature ascospores. × 1175.
4. Paraphyses. × 1175.
5. Habit diagram to show apothecia growing on surface of Trichoglossum hymenium. × 85.
6. Vertical section through a very young apothecium showing ascogonial coil and beginnings of ascogenous hyphae among marginal paraphyses. Dotted line to left indicates extent of gelatinous material which covers the apothecium. × 1175.
7. Vertical section through a nearly mature apothecium to show arrangement of asci, paraphyses, and marginal filaments. Darker cells at base envelop the curved Trichoglossum paraphyses. × 800.

Fig. 8–12. *Sphaeronaemella Helvellae* Karsten, emend. Seeler.

8. a. Diagrammatic sketch of exterior of mature perithecium to show tile-like cells forming body, filaments forming neck. Dotted line at apex indicates ball of spores. × 65.
   b–c. Outlines of young and of mature perithecia. × 65.
9–10. Asci (spores immature) and mature ascospores. × 1175.
11. Apex of neck of perithecium showing ascospores in single row. × 1175.
12. Conidiophore and conidia which grew on the outside of the perithecium. × 1175.

1–7. Drawn from Nantucket, Mass. material. *Seeler.* 8. and 10–12. from Shelburne, N. H., *Farlow.* 9. from cotype, Fungi Fenn. *674.*

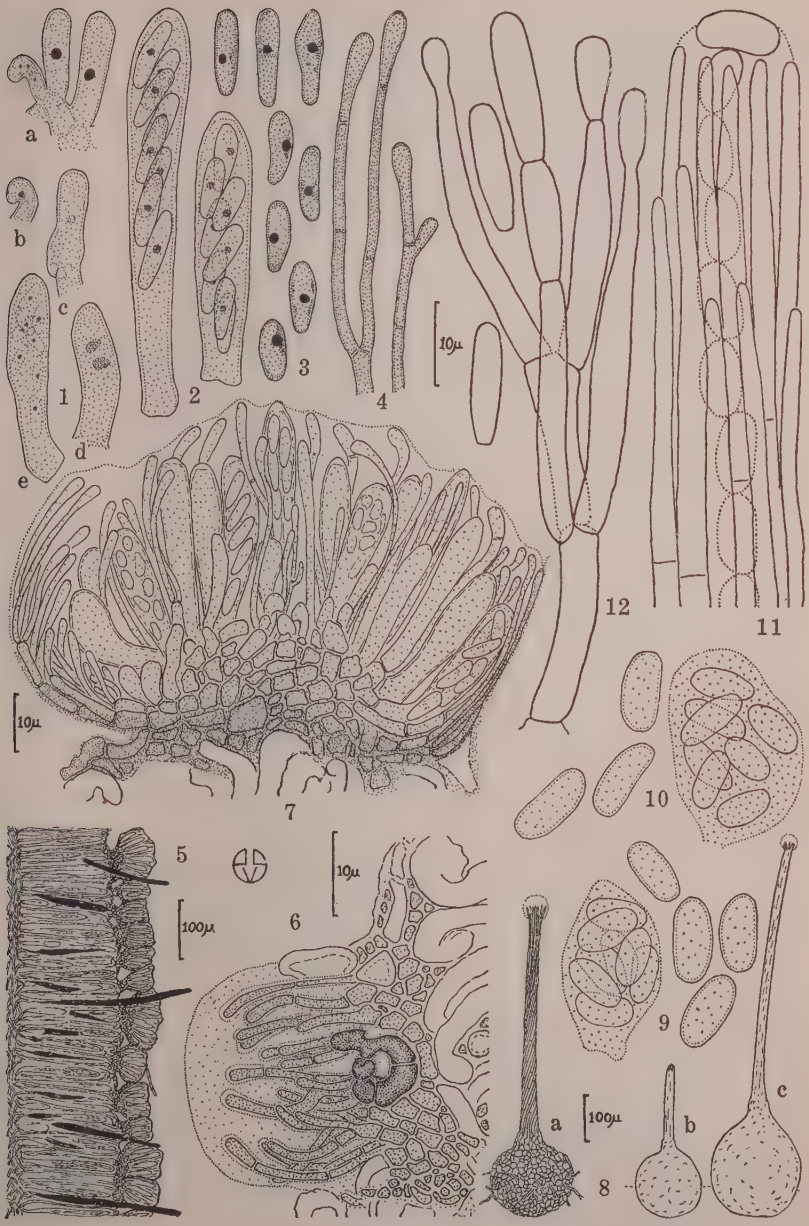



PLATE II

1(1): 135–170 FARLOWIA January, 1943

# STUDIES IN THE GENUS HELOTIUM, III HISTORY AND DIAGNOSIS OF CERTAIN EUROPEAN AND NORTH AMERICAN FOLIICOLOUS SPECIES [1]

W. Lawrence White

The object of the present paper is to present as thorough a taxonomic study as available material will permit of the species of *Helotium* (sensu latu)[2] occurring on the *blades* of fallen, decaying leaves of woody dicotyledonous plants in Europe and North America. If such a paper would be more than another incident in an historical background of inaccuracy and confusion, and in itself a perpetuation of and an addition to such a preëxisting condition, it must present more than the usual series of species descriptions: it must undertake rather completely to review and disentangle the whole literature record of the several species which fall within the scope of its restricted subject.

To this end the study is first of all based on an examination of types, for in a genus where taxonomic characters are as wanting as they are in this one[3] many if not the great majority of the species simply cannot be interpreted from the brief original diagnoses that have been presented in the past; neither can their identity be established by later diagnoses, which are often based on incorrect determinations, nor, except very rarely [e. g., *H. epiphyllum* (Pers. ex Fr.) Karst], by general agreement or usage. To illustrate by a single example: *H. phyllophilum* (Desm.) Fr. was described by Desmazières from France in 1842, and the original material, said to be on *Acer* and *Fagus*, was widely distributed to herbaria as an exsiccati number. Accompanying it was a diagnosis sufficiently vague (as is to be expected of that period) to apply almost equally well to any of the species from numbers 7 to 13 inclusive in the present paper. Having been listed on two substrate species it is possible that a mixed fungus species is involved. The packets which I have examined from several herbaria, however, all contain leaves of *Fagus* bearing good and abundant apothecia of a single well-defined species. The point to be made is that of eighteen later collections under the specific epithet of Desmazières which have been available for examination — and despite the general availability of the original material — five distinct species are represented, none of which agrees with the original material on *Fagus* leaves.

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 216.

[2] But not in the all-inclusive sense of early mycologists who placed here species now correctly referred to *Ciboria*, *Chlorociboria*, *Chlorosplenium*, *Rutstroemia*, and several other genera. In the first paper of this series (Mycologia **34**: 154–179, *fig. 1–16*. 1942). ten of the eighteen species described in *Helotium* by Peck were excluded and placed elsewhere. Despite this gradual narrowing, however, the so-called genus as it still is recognized (White, Amer. Midl. Nat. **28**: 512–523. 1942) is large and in the light of modern generic concepts probably diverse.

[3] Cf. Amer. Midl. Nat., l. c.

Secondly, an attempt is made either to confirm or reidentify all of the European (omitting *H. epiphyllum*) and American exsiccati specimens, as well as others taken within this range, because, among several reasons, these must be used as a basis for comparison for future determinations by those who do not have access to the types, and further because they are the basis of our knowledge of the geographic and substrate ranges for the species. The fallacy of basing any mycogeographical studies on the now-existing records of the aforementioned *H. phyllophilum* is at once apparent. The effect of sorting out and redetermination of historical material on known geographical distribution may again be illustrated by *H. immutabile*, which was described by Fuckel from Germany in 1871. Removing *H. immutabile* from synonymy with *H. conformatum* (Karst.) Karst., to which it is scarcely remotely related, takes it out of Scandinavia, and a correction of the only previous report of the species from North America takes it out of Canada; finding it in herbaria under incorrect names takes it to Italy, Massachusetts, New Jersey, and Minnesota.

Thirdly, the paper aims to provide a complete bibliography of each species, except for the first, *H. epiphyllum*, for which European references have been omitted for want of space, and to indicate whether or not they are correct. This goes hand in hand with the examination of specimens as indicated in the preceding paragraph and is necessary for the same reasons. And there is still another factor involved: the amount of exploring for these forms has been so scanty that it becomes necessary to search out the basis of each local report in order to get material for study. This, of course, has been supplemented as much as possible by a study of fresh material. At first thought it appears impossible to check any appreciable number of literature references — but the literature is not very extensive, and fortunately, type and other historic material of the helotiaceous fungi has been well preserved and a fair concentration of it is to be found in the various institutions of northeastern United States. Having been privileged over a considerable period to work in the larger herbaria of this region, especially those of Harvard, Cornell, and the New York Botanical Garden, each generally rich in exsiccati material and library facilities, and each excelling in its own particular private collections — i. e., Harvard with its von Höhnel and Patoulliard collections and others, Cornell with its Durand collection of 12,000 discomycetous specimens including a fragment from nearly every specimen that was the basis of a North American literature record up to about 1905, and the New York Botanical Garden with its Massee herbarium of British material — I feel that the opportunity for such a study has been ample. To be sure, some type and otherwise important material has been unavailable, and a number of species therefore must be left for future reference.

It is hoped that this treatment, together with those references indicated

in the following key, may enable the investigator to determine most of the foliicolous species of *Helotium* and Helotium-like fungi which occur in central and western Europe and northeastern United States. The remaining vast areas of both continents remain "untouched" as far as such fungi as these are concerned.

A certain degree of substrate specificity permits the grouping of the helotiaceous fungi for purposes of convenience as occurring on leaves, petioles, wood, fruits, grasses, herbaceous stems, etc. Strict attention to phylogeny might well be left until a complete monograph of a genus or family can be prepared; to attempt it now, especially in view of the relative lack of outstanding characters in these forms, either specific or of higher category, could result only in a rapid series of name changes, or at best a series of papers which could bear little or no meaning to the non-specialist. Of primary concern is the placing of the individual species on a sound taxonomic basis. With phylogeny ultimate, however, the following remarks on the species of this paper may be pertinent.

The first three species, *H. epiphyllum* (Pers. ex Fr.) Karst. (plus *Ombrophila subaurea* Cooke, which is appended as doubtfully distinct), *H. carpinicolum* Rehm, and *H. immutabile* Fuckel, are surely very closely allied. They undoubtedly form a natural taxonomic unit with certain similar forms such as are usually referred to as *H. lutescens* (Hedw.) Fr. or *H. pallescens* (Pers.) Fr., which occur on wood. It is certain that *H. epiphyllum* is not confined to leaves, and some specimens now in herbaria under the two names just mentioned may be referable to this species. Number four, described as new, shows affinities with those preceding it but is somewhat uncertain. Number five, *H. Conocarpi* Seaver, is included because it might be looked for here; as indicated later in the discussion of that species it probably belongs in the Ciborioideae. The sixth, presented as new, appears to be intermediate between the *H. epiphyllum* group and the slender, stipitate, and more or less delicate forms represented by numbers 7 to 13, inclusive. The latter group most certainly forms a highly natural series and is allied with a group consisting of *H. scutula* (Pers. ex Fr.) Karst., *H. fraternum* Peck, and *H. Dearnessii* (Ellis) White, which occur on substrata other than leaf blades. The punctiform species (*Pezizella* sensu Rehm) represented by numbers 14 to 17 are of uncertain affinities — perhaps miscellaneous — yet scarcely set off from the *H. epiphyllum* group by any obvious character except by the smaller dimensions, and from the *H. caudatum* group (no. 7–13) by anything other than the lack of a long, slender stipe.

As to materials and methods, all observations and drawings of microscopic structures are based on material mounted in KOH-phloxine (Martin, Mycologia **26:** 261–265. 1934) and studied under the oil immersion objective. The figures are drawn with the aid of a camera lucida to a magnification of 1540 (with the exception of no. 4, which is x 1835) and reduced slightly on reproduction. Descriptions of gross morphology and

surface markings are based on material observed under a good binocular. Technical color terms are those of Ridgway.

In the citation of literature, references known to be based on incorrectly determined material are enclosed in brackets. The basis for indicating a record as incorrect or for allowing it to stand may be determined by a perusal of the material examined or of the discussion in the treatment of the particular species.

The specimens examined are listed geographically and chronologically. Whenever a specimen cited under a particular species has been filed or distributed under an incorrect name the latter is given and is enclosed in brackets. The herbarium in which each specimen examined is located is indicated by an abbreviation in parentheses. The abbreviations are those of Lanjou (Chronica Botanica **5**: 142–150. 1939) with an additional letter added in many cases to designate the private collections of the various institutions. The meanings of the latter will be apparent to most workers who have reason to pay any attention to them; most of them are listed in the first paper of this series (Mycologia **34**: 154–179. 1942).

## KEY TO THE SPECIES

1. Apothecia sessile, subsessile, or with stipe present but obscure or at least much shorter than the diameter of the disc.
   2. Apothecia large, fleshy, 1–4 mm. diameter.[4]
      3. Apothecia broadly sessile, watery and sordid when fresh, drying soiled-ochraceous; paraphyses branched at the apex; North American. **4. H. contortum**
      3. Apothecia attached by a narrow central papilla or having a short stipe; paraphyses not branched at the apex.
         4. Spores obovoid, regular and equilateral in outline, not larger than 10–13 x 4–5 μ.
            5. Spores of the dimensions indicated above, slightly trapezoid-shaped; apothecia white when fresh, drying yellow or orange; on various species in Europe and N. Am. ..... **3. H. immutabile**
            5. Spores slightly smaller, not at all trapezoid in outline; apothecia dark brown when dried; on *Conocarpus* in Bermuda **5. H. Conocarpi**
         4. Spores more elongate, more or less fusoid. inequilateral or flattened on one side, more than 13 μ long; apothecia drying pale to deep orange.
            6. Spores narrow oblong-fusoid asymmetrical or slightly curved, 16–24 x 4–5 μ ..... **1. H. epiphyllum**
            6. Spores elongate-ellipsoid, scarcely fusoid, flattened on one side or slightly curved, 13–16 x 4–4.5 μ ..... **2. H. carpinicolum**
   2. Apothecia minute, 0.1–0.8 mm. in diameter.
      7. Apothecia lemon-yellow, thin, plane, puberulent; spores distinctly long and narrow, 12–18 x 1.8–2.6 μ ..... **17. H. puberulum**
      7. Apothecia and spores not entirely as above.
         8. Apothecia up to 0.8 mm. in diameter, subfleshy, deeply concave, then saucer-shaped, pale to ochraceous yellow, easily visible to the unaided eye ..... **14. H. populinum**

[4] Cf. also *Pycnopeziza* (White & Whetzel, Mycologia **30**: 187–203. 1938; Whetzel & White, Mycologia **32**: 609–620. 1940), or if brown-spored, *Phaeociboria:* one species occurring on *Hedera Helix* L. in Europe (l. c., p. 614).

8. Apothecia not over 0.3 mm. diameter when fresh, translucent whitish or brownish, drying dirty ochraceous or brownish and scarcely or not at all visible to the unaided eye.
9. Paraphyses forked at the apex; spores 2-celled; North American.
**16. Pezizella glagosa**
9. Paraphyses not branched at the apex; spores always 1-celled.
10. Apothecia with a short but distinct stipe; asci 75–95 x 10–11.5 μ; spores obovoid, 12–15 x 4–4.5 μ; North American.
**6. H. translucens**
10. Apothecia erumpent, then broadly sessile; asci 40–46 x 8.5–9 μ; spores oblong, 12–13 x 2.8–3.3 μ; on leaves of *Betula* in Europe.
**15. H. tumidulum**

1. Apothecia distinctly stipitate, the stipe slender, as long as the diameter of the disc or longer. (Slender delicate species, white to yellow or pale ochraceous, not over 2.5 mm. high).[5]
11. Apothecia with lower half of stipe black; spores small, narrow-oblong, 6–8 x 1.4–1.8 μ; on leaves of *Chamaedaphne* in North America.
**13. Phialea Cassandrae**
11. Apothecia not with stipe as above; spores conspicuously larger.
12. Spores distinctly long and narrow, 28–36 x 3.5–4.5 μ; North American.
**7. H. fastidiosum**
12. Spores not more than 25 μ long.
13. Hymenium drying cinereous; spores 16–18 x 3.5–4 μ; North American.
**9. H. Linderi**
13. Hymenium drying pale ochraceous.
14. Spores 16–24 x 4.5–5.5 μ; Europe and North America.
**8. H. caudatum**
14. Spores smaller, not more than 16 μ long.
15. Asci originating from croziers; spores narrow oblong-fusoid, distinctly 2-celled, 11.5–15 x 3.2–4 μ; European.
**12. H. phyllophilum**
15. Asci not originating from croziers; spores 1-celled.
16. Spores narrow, 14–16 x 3.5–4 μ; on leaves of *Fagus* in North America ..... **10. H. albopunctum**
16. Spores broader, 11–14 x 3.8–5 μ; on leaves of *Populus* in Europe ..... **11. H. phyllogenon**

## THE SPECIES

**1. Helotium epiphyllum** (Pers. ex Fr.) Fr., Summa Veg. Scand., p. 356. 1849. — Cooke, Handb., p. 715. 1871. — Peck, New York St. Mus. Rep. **25** (1871): 98. 1873. — Cooke, Bull. Buffalo Soc. **2**: 299. 1875. — Frost, Cat. Pl. Amherst, p. 91. 1875. — Harkn. & Moore, Cat. Pacific Fungi, p. 37. 1880. — Bundy, Geol. Surv. Wisconsin 1873–79 **1**: 401. 1883. — Peck *in* Day's Cat., Bull. Buffalo Soc. **4**: 220 (156). 1883. — Cobb, List Pl. Amherst, p. 47. 1887. — Sacc., Syll. Fung. **8**: 227. 1889. — Ellis *in* Britt., Cat. Pl. New Jersey, Rep. St. Geol. **2**: 550. 1890. — Atk. & Schrenk, Journ. El. Mitch. Soc. **9**: 106 (12). 1893. — Lindau *in* Engl. & Pr., Nat. Pfl. $1^1$: 207. 1894. — Durand, Bull. Torrey Club **27**: 483. *pl. 31, fig. 13.* 1900. — Kauffm., Rep. Michigan Acad. **8**: 28. 1906. — Millsp., West Virginia Geol. Surv. **5**(A): 111. 1913. — Dodge, Journ. Wisconsin Acad. **17**: 1034. 1914. — Kauffm., Rep. New York St. Mus. **68**: 83. 1915. — Burnh.

[5] If brown, or if they become brown on drying, compare in *Rutstroemia* (White, A Monograph of the Genus Rutstroemia (Discomycetes). Lloydia **4**: 153–240, *fig. 1–75.* 1941); if white or bright colored, but larger and more robust, compare in *Ombrophila*, especially *O. clavus* (Alb. & Schw.) Fr.

& Lath., Torreya **23**: 5. 1923. — Bisby et al, Fungi Manitoba, p. 62. 1929. — Cummins, Papers Michigan Acad. **11**: 111. 1930. — Stev., Claytonia **3**: 25. 1936. — Linder, Mycologia **29**: 372. 1937. — Bisby et al, Fungi Manitoba & Sask., p. 40. 1938. — Mains et al, Mycologia **31**: 730. 1939. — Wehm., Canadian Journ. Res. **18**(C): 547. 1940.

*Peziza epiphylla* Pers., Tent. Disp. Fung., p. 72. 1797. — Fr., Syst. Myc. **2**: 137. 1822. — Schw., Naturforsch. Gesell. Leipzig Schr. **1**: 122. 1822. — Schw., Trans. Amer. Phil. Soc. **4**: 175. 1834. — Curtis, Bot. North Carolina, p. 134. 1867. — Cooke, Bull. Buffalo Soc. **2**: 299. 1875.

*Helotium aurantiacum* Cooke ex Phill., Grevillea **92**: 106. 1891. — *Nom. nud.* Cooke *in* Britt., Cat. New Jersey Pl., Rep. St. Geol. **2**: 550. 1889. — Sacc., Syll. Fung. **10**: 8. 1892.

*Calycina aurantiaca* (Cooke ex Phill.) Kuntze, Rev. Gen. Pl. **3**$^2$: 448. 1898.

*Calycina epiphylla* (Pers. ex Fr.) Kuntze, Rev. Gen. Pl. **3**$^2$: 448. 1898.

*Hymenoscypha epiphylla* (Pers. ex Fr.) Rehm ex Kauffm., Papers Michigan Acad. **9** (1928): 177. 1929.

FIGURE 1.

**Apothecia** scattered, sparse to rather numerous, solitary or more rarely in groups of 2–4, bright yellow to bright or dull orange when fresh, all parts more or less concolorous, the color not changing markedly on drying, fleshy, sessile to short-stipitate, reaching a diameter of 4 mm. and a height of 1.8 mm., drying waxy to waxy-cartilaginous; **stipe** absent or short, commonly merely a papilla or a narrowed basal portion of the disc, more rarely cylindric and distinct, entirely smooth, pale yellow or yellow when fresh, yellow to pale orange on drying; **receptacle** smooth, concolorous with stipe, retaining its fullness on drying; **disc** opening by a pore very early, fleshy, saucer-shaped, at maturity nearly or quite plane, sometimes repand with maximum moisture; **hymenium** yellow when fresh, on drying becoming deep yellow to orange or even a deep dull red; **margin** thick, even; **in section** composed largely of a thick, compact, homogenous tissue of thin-walled, short-celled hyphae 3–5 $\mu$ diam. and a more or less distinct ectal layer; **ectal layer** at least in the region of the stipe consisting of thin-walled isodiametric cells 8–14 $\mu$ diam., this structure continued to or nearly to the margin or gradually giving way to a less well differentiated tissue made up of the slightly enlarged and compacted and upwardly directed hyphal tips from the medullary region; **paraphyses** long, straight, scarcely or not at all thickened at the apex, 2–3 $\mu$ diam.; **asci** originating from croziers, clavate, 90–130 x 9–12 $\mu$, the pore faintly colored with iodine; **ascospores** fusoid or oblong-fusoid, more or less asymmetrical or slightly curved, 1-celled, 16–23 x 4–5 $\mu$, uniseriate, sometimes biseriate above, the content granular, sometimes with two or three definite oil globules.

HABITAT: North American material on leaves of *Abies* (Cummins), *Acer*, *Alnus* (Kauffm.), *Amelanchier*, *Betula*, *Castanea* (also on pericarps), *Fagus*, *Populus*, *Quercus*, and species indet.; also on forest debris of various kinds: twigs of oak and other species, fern fronds, herbaceous stems, and rabbit dung.

DISTRIBUTION: Quebec, Nova Scotia (Wehm.), New Hampshire, Massa-

chusetts, New York, New Jersey, Pennsylvania,* Maryland,* District of Columbia,* West Virginia, Virginia* (Stev.), North Carolina, South Carolina, Tennessee, Michigan, Wisconsin (Bundy), Manitoba (Bisby), Montana, California (Harkn.). The best known and perhaps the most widely distributed of the leaf-inhabiting species of *Helotium*. Common both in North America and in Europe.

Material examined: **Quebec:** Duchesnay, County Portneuf, Aug. 25, 1938, *H. H. Whetzel & T. Sproston* [as *H. phyllophilum*] (CU-P *27850*). — Duchesnay, Aug. 26, 1938, *R. F. Cain 11154* [as *H. immutabile*] (TRT). — **N. H.:** White Mts., Sept. 1884, *Miss Minns* (CUP-D *8443*). — Shelburne, Sept., '91 (FH). Gilmanton, Oct. 12, 1942, *D. H. Linder* (FH). — **Mass.:** Canton, 1925, *D. H. Linder* (FH). — Canton, July 1933, *D. H. Linder* (FH). — Swamp near Squam, Nantucket, Sept. 8, 1942, *E. V. Seeler 730a* (FH). — Drake's Marsh, Maddeket, Nantucket, Sept. 11, 1942, *E. V. Seeler 730b* (FH). — Cushman, Sept. 12, 1942, *T. Sproston* (FH). — **N. Y.:** Enfield, Aug. 20, 1935, *W. L. White 2022 & H. J. Miller* (FH). White Lake, Adirondack Mts., Sept. 2, 1936, *Whetzel & White* (CU-P *25519*, FH). — Newcomb, Huntington Wildlife Forest, Adirondack Mts., Sept. 6–17, 1941, *Rolf Singer* (FH). **N. J.:** Newfield, Sept. 18, 1875, as *H. aurantiacum* (CUP-D *8399, 8400*, NY-E *940*). — Newfield, Oct. 1875, *J. B. Ellis*, Type ? of *H. aurantiacum* (CUP-D *3748*). — Newfield, 1874, *Ellis*, Thümen, Myc. Univ. *315*, as *H. epiphyllum* (CUP-D *10376*). — Newfield, Oct. 1, 1879, as *H. aurantiacum* (CUP-D *8401*, NY-E *3332*). — Newfield, July 28, 1883, *Ellis*, as *H. epiphyllum* (CUP-D *8442*). — Newfield, July 1889, Ell. & Ev., N. Am. Fungi *2328* (FH). — **W. Va.:** Nuttallburg, Aug. 1896, *L. W. Nuttall*, Ell. & Ev., Fungi Columb. *1023* (CUP-D *10304*, FH). — **N. Car.:** Cranberry, alt. 3250 ft., July–Aug. '87, *R. Thaxter* (FH). — Blowing Rock, Blue Ridge Mts., alt. 3500–5000 ft., July 20–Sept. 14, 1901, *E. J. Durand* (CUP-D *12398*). **S. Car.:** Aiken, on damp, fallen leaves of *Cerasus*, Dec. 1880, *Ravenel 3128*, as *H. epiphyllum* var. *Cerasi*. [Have seen only a fragment and it is not typical of the species.] (CUP-D *3742*). **Tenn.:** Grassy Patch, Great Smoky Mts. Nat. Park, elev. 4200 ft., Aug. 18, 1939, *D. H. Linder* (FH). — Indian Gap, Great Smoky Mts. Nat. Park, Aug. 20, 1939, *D. H. Linder* (FH). — **Mich.:** Nubish, Sept. 1917, *E. T. & S. A. Harper S199* (CUP-D 10828). — Marquette, 9/11/34, *E. B. Mains 34–149* (FH). **Mont.:** Echo Lake, Flathead Nat. Forest, July 20, 1928, *G. B. Cummins;* comm. Dr. Kanouse (MICH).

The species appears to exhibit, within well defined limits, a certain amount of variation in form and structure of the apothecium, and an occasional specimen, such as the one cited above from South Carolina and another (not cited) taken at Cranesville, W. Va., Aug. 6, 1908, by J. L. Sheldon (CUP-D *6471*) has spores shorter and more obtuse than are normal for the species, in this latter respect resembling *H. carpinicolum* (described on the following pages). As I have presented *H. epiphyllum* here, it is characterized by its rather large and fleshy, substipitate orange-colored apothecia, long asci originating from croziers (cf. *Ombrophila subaurea*, mentioned below), and distinctly elongate and fusoid spores. Durand (l. c.) describes and illustrates a very distinct pseudoparenchymatous ectal excipulum extending around the apothecium from the substratum nearly to the margin. However, Lagarde (Ann. Myc. **4:** 234–235, *fig. 53.* 1906), presenting a detailed anatomical and morphological study

* fide Miss Cash from material in Pathol. & Mycol. Collections, U. S. D. A.

of the species, presumably based wholly or largely on European material, indicates that he never encountered this layer in the material he examined, although he did find the hyphal tips compacted in such a way as to form an outer zone rather distinctly different from the tissue of the broad middle region. In my own experience I have found the outer layer to be always pseudoparenchymatous in the basal region at or near the stipe, and sometimes extending well up toward the margin, but scarcely in any case as distinctly defined as illustrated by Durand. The latter is more typical of the two species following, *H. carpinicolum* and *H. immutabile*, than it is of *H. epiphyllum*. Note the variation in form shown by Nannfeldt (Nova Acta Reg. Soc. Sci. Upsala 4: **8**[2]: *pl. 14, fig. 2–4.* 1932) in photomicrographs of three different European collections. I have examined numerous collections from Europe and fail to find any differences in the species as it occurs typically in Europe and as it occurs in North America.

The species which I have here referred to synonymy with *H. epiphyllum*, that is, *H. aurantiacum*, does not appear to have received any attention since the original description by Phillips. Phillips lists the material on which his description is based as "J. B. Ellis, No. 75" without date or locality, and it is impossible at present to be sure which of the three specimens cited above, if any, actually represents the type. That of Oct., 1875, is marked "Type" on the portion which is in the Durand Herbarium. It contains a single apothecium which is sessile and 2 mm. in diameter. The Durand portion of the 1879 material has apothecia up to 4.5 mm. in diameter, and of the Sept. 18, 1875, collection up to 1.3 mm. diam.; in both they are sessile to substipitate. They all obviously represent the same species and are typical *H. epiphyllum*.

Several varieties of *H. epiphyllum* remain to be investigated: var. *acarium* Karst., var. *candidum* Karst., var. *Ellisii* Rehm, var. *praeponens* Karst., and perhaps others.

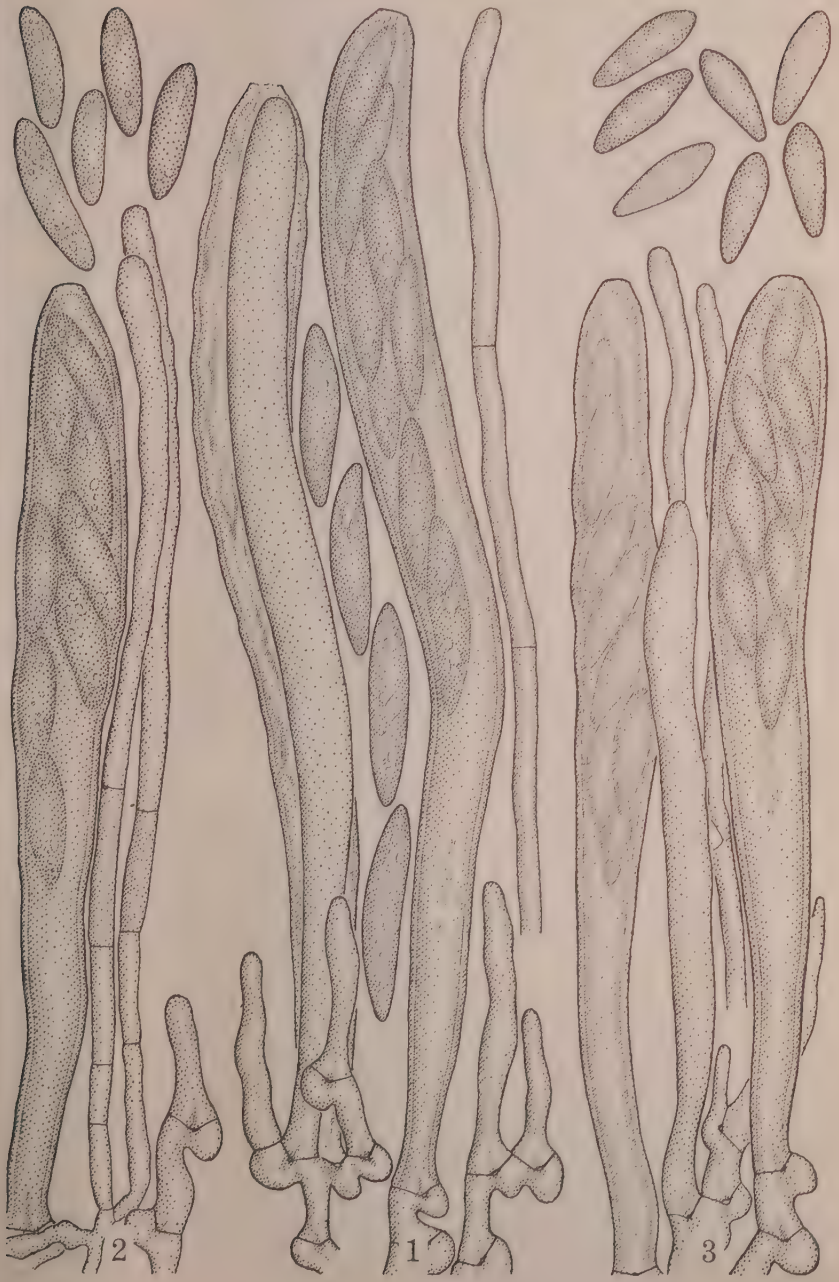
**Ombrophila subaurea** Cooke, Bull. Buffalo Soc. Nat. Sci. **2**: 300. 1875.

The material of Ellis, N. Am. Fungi *394*, which presumably is type, differs from typical *Helotium epiphyllum* only in that croziers are entirely lacking. This is the only material I have seen with the spores and other characters of *H. epiphyllum*, yet lacking croziers. Cooke's name may remain unaltered pending future investigation.

**2. Helotium carpinicolum** Rehm, Hedwigia **35**: 146. 1896. — Sacc., Syll. Fung. **14**: 764. 1899. — Boud., Hist. Classif. Discom. Eur., p. 113. 1907. — Gola, Erb. Mic. Sacc. Cat., p. 119. 1930. — Nannf., Nova Acta Reg. Soc. Sci. Upsal. 4: **8**[2]: 298, *pl. 14, fig. 1.* 1932. — [Vel., Monogr. Discom. Bohem. **1**: 204. 1934.]

FIGURE 2.

**Fig. 1–3:** **1**, *Helotium epiphyllum*, from the type ? of *H. aurantiacum* (CUP-D *3748*); **2**, *H. carpinicolum*, from Rehm's Ascom. *1157*, type (FH); **3**, *H. immutabile*, from Fuckel's Fungi Rhenani *2388* (FH). All drawings × 1290.




FIGURES 1–3.

**Apothecia** sparse, solitary or more rarely in groups of two or three, arising from the mid, lateral, and net veins of the leaf, sessile, reaching a diameter of slightly more than 1 mm. in the dried condition and exhibiting a bright orange color in all stages of development; at first papillate, erumpent, then more or less erect, columnar, sometimes distorted, enlarged at the apex, opening by a pore, very early becoming saucer-shaped to plane, thick, fleshy, finally reaching a diameter of 0.7–1.2 mm., the largest up to 1.6 mm. on being moistened; at maturity attached by a central papilla; **receptacle** concolorous with or frequently slightly more yellowish than the hymenium when dry and slightly raised above the substratum, when moistened lying closely adjacent to it; **hymenium** in the dried condition plane to slightly convex, orange colored: "Ochraceous Orange," "Zinc Orange," or "Apricot Orange" (R), on moistening becoming pale yellow and strongly convex; **margin** smooth, in dried specimens slightly upturned in young material, scarcely so with age, lying closely adjacent to the substratum when moist; **in section** composed of a thick medullary excipulum of closely interwoven, narrow, thin-walled hyphae, and a distinct ectal layer rather thin and made up of closely arranged, globular, thin-walled cells 7–12 $\mu$ diam., this layer grading above into a marginal tissue of parallel, rectangular cells 7–12 x 3.5–5 $\mu$ directed outward and upward in filaments ending in cells with obtuse rounded ends, of the same diameter, and closely appressed to form a smooth external surface; **paraphyses** simple, not enlarged at the apex, 3–3.5 $\mu$ diam.; **asci** 90–110 x 11–13 $\mu$, arising from crosiers; **ascospores** biseriate or sub-biseriate, ellipsoid-cylindric, flattened on one side, 13–16 x 4–4.5 $\mu$, always one-celled, those from dried specimens containing a small amount of scattered refractive granular material in each end.

HABITAT: On leaves of *Carpinus Betulus* L.; also reported on *Fagus sylvatica* L.

DISTRIBUTION: Germany; also reported from Czechoslovakia. Sept.–Oct.

MATERIAL EXAMINED: **Germany:** "Jungfernhaide bei Berlin. An faulenden Blättern von Carpinus Betulus." 9/1894, *Sydow*, Rehm, Ascom. *1157*, **type** (FH, FH-P, NY-E). — "Ad folia putrida Carpini Betuli. Marchia: Bredower. Forst pr. Nauen." Oct. 1896, *P. Sydow*, Rabenh.-Pazsch., Fungi Eur. et Extraeur. *4271* (FH).

This species is extremely close to *Helotium epiphyllum*, but I am convinced that it is distinct — and possibly local in occurrence. The two German specimens cited above are strictly uniform in their characters, and in comparison with most of the material that has been referred to *H. epiphyllum* they are smaller, tend to be more definitely sessile, in the dried condition remain more fully expanded, in section exhibit a more distinct ectal excipulum of small isodiametric cells, have shorter asci, and have smaller spores with ends rounded rather than pointed. Nannfeldt's (l. c.) photomicrographs of the apothecia of the two species in section scarcely show any differences.

It appears highly probable that some of the central European specimens now in herbaria as *H. epiphyllum* will prove on closer examination to be *H. carpinicolum*, and there is no reason to suppose that all of them will be on *Carpinus*.

**3. Helotium immutabile** Fuckel, Symb. Myc., Nachtr. I, p. 50. 1871. — Sacc., Padova. Soc. Venet. Trent. Sci. Atti **4**: 137. 1875. — Phill., Man. Brit. Discom., p. 162. 1887. — Sacc., Syll. Fung. **8**: 241. 1889. — Massee, Brit. Fung.-Fl. **4**: 259. 1895. — Gola, Cat. Erb. Mic. Sacc., p. 120. 1930. — [Mycologia **31**: 730. 1939.]

*Helotium conformatum* auct. non Karst. — Rehm *in* Rabenh. Krypt. Fl. **1**[3]: 780. 1893. — Jaap, Abh. Bot. Ver. Prov. Brandenburg **52**: 5. 1910. — Migula *in* Thomé's Krypt.-Fl. **10**[2]: 1197. 1913. — Nannf., Nova Acta Soc. Sci. Upsal. 4: **8**[2]: 298, *pl. 15, fig. 1*. 1932.

*Pachydisca immutabilis* (Fuckel) Boud., Hist. Classif. Discom. Eur., p. 94. 1907. — Ramsb., Brit. Myc. Soc. Trans. **4**: 371. 1913.

FIGURE 3.

**Apothecia** sparse, solitary, short-stipitate, white when fresh, drying yellow to orange, 0.8–1.5 mm. diameter; **stipe** short, distinct, 0.2–0.5 mm. long, firm, straight, cylindric below and slightly enlarged above, sometimes obconic, abruptly or gradually expanded into the disc, smooth, always concolorous with receptacle; **disc** of medium thickness, spreading, changing but little on drying, plano-convex or repand; **receptacle** smooth and white when fresh, pale yellow to pale orange on drying, not wrinkled, sometimes marked with very fine superficial striae radiating from upper part of stipe to margin, these disappearing on moistening; **hymenium** when fresh white, convex, drying firmly waxy, plane to slightly convex, pale yellow or in old herbarium specimens becoming pale orange-red or deep reddish brown; **margin** even, subacute, at maturity little or not at all elevated above the hymenium either when fresh or dried; **in section** composed of a broad medullary region of rather loosely interwoven, thin-walled, irregular, branched, septate hyphae 2.5–6 $\mu$ diameter, and a thin well defined ectal layer composed of thin walled compactly arranged globular cells 9–16 $\mu$ diameter; **paraphyses** once forked below the middle, scarcely enlarged at the apices, 3–3.5 $\mu$ diameter; **asci** clavate, arising from croziers, 80–105 x 8–10 $\mu$, the pore faintly blue with iodine; **ascospores** uniseriate to sub-biseriate, 1-celled, angular-obovoid, 10–13 x 3.8–4.6 $\mu$, the content rather finely and evenly granular when fresh, homogeneous in herbarium specimens or with a few minute scattered oil globules in the ends.

HABITAT: Apothecia arising from the veins, petioles, and parenchyma of decaying leaves: in N. Am. on *Robinia Pseudoacacia* L. and sp. indet.; European specimens listed on *Populus nigra* L., *P. tremula* L., *Quercus pedunculata* Ehrh., *Quercus* sp., and *Ulmus campestris* L.; reported by Velenovský on *Betula* sp., *Carpinus* sp., and *Quercus* sp., but his fungus almost certainly was incorrectly determined.

DISTRIBUTION: Massachusetts, New Jersey, and Minnesota — June–Oct.

23; in Europe from Germany, ? Czechoslovakia, Italy, and England — October.

MATERIAL EXAMINED: **North America: Mass.:** "Ad fol: putresc: in humidis" June, *C. J. Sprague 1231*, as *Peziza* indet. (FH-C). — On *Robinia Pseudoacacia* L., leaflets, racheae, and petioles, Wakefield, Oct. 23, 1942, *D. H. Linder* (FH). — **N. J.:** On decaying leaves, etc., in muddy places, June & Sept. 1879, Ell. & Ev., N. Am. Fungi *393* [as *Ombrophila purpurascens* Fr.] (FH). — **Minn.:** On decaying leaves on wet ground, Purgatory Swamp, Hennepin Co., Sept. 20, 1918, *E. J. D.* [as *Helotium* sp. but filed under *H. epiphyllum*] (CUP-D *10656*). — **Europe: Germany:** "Ad Populi tremulae folia putrida, raro. Aut. Boss pr. Eberbach." Fuckel, Fungi Rhen. *2388*, **type** (FH). — Portion of same collection ? Herb. Barb.-Boiss. *1215* (FH). — "Auf Populus tremula. Zehlandorf bei Berlin." *Sydow*. Myc. March. *678* [as *H. epiphyllum* Pers. var. *candidum* Karst.] (FH). — "An Quercus Blattern. Berlin, Wannsee." 10,1894, *Sydow*, Myc. March. *4258* [as *H. conformatum*] (FH). — "Auf Quercus pedunculata. Berlin. Wannsee." 10,1895, *Sydow*, Myc. March. *4436* [as *H. conformatum*] (FH). — "Auf faulenden Blättern von Quercus pedunculata. Brandenburg: Bredower Forst bei Nauen." 7–10–'06, *Sydow*, Myc. Germ. *600* [as *H. conformatum*] (FH). — **Italy:** "Padova, in foliis putridis Ulmi campestris, Oct. 1878." Sacc., Myc. Ven. *1387* [as *H. epiphyllum*] (FH).

The distinctive character of the species is its trapezoid spores which are symmetrical in outline and very constant in size and shape. The apothecia of the one and only collection I have seen in the fresh condition were pure white. On drying they changed shape but little, and after about three weeks in the herbarium have turned no darker than a very pale yellow: the stipe and receptacle are "Cream Color" (R) and the hymenium "Maize Yellow." In the Minnesota collection cited, taken about 25 years ago, the apothecia are bright yellow. In most of the older herbarium material, however, they are pale to deep orange.

The species is of the same general aspect as *H. carpinicolum* to which it corresponds closely in color, size, structure, and habitat. It differs, however, in being somewhat larger, distinctly stipitate, and finally and more definitely in its characteristic, though not pronouncedly, trapezoid spores.

Some confusion has been caused by Rehm's reference of this species to synonymy under *H. conformatum* Karst. to which it is not at all related. Karsten's species as indicated by his description and his Fung. Fenn. Exsicc. *738* is a species of *Rutstroemia* and I hope to deal with it in another paper in the near future. Rehm notes that he did not see Karsten's specimen and that his interpretation is based only on the description. Study of Rehm's description together with an examination of the exsiccati material which he cites (except Ascom. *152*, which is not available) indicates that he actually was working with *Helotium immutabile*, not *H. conformatum*. Nannfeldt's illustration [sub nom. *H. conformatum*], which was made from Sydow's Myc. Germ. *600*, also represents *H. immutabile*.

Velenovský in his Discomycetes of Bohemia illustrates side by side two species, one of which he refers to *H. conformatum* with *H. immutabile*

indicated as synonymous, and the other he describes as new, *H. trapezoideum* Vel. The material which he identifies with *H. conformatum* appears almost certainly to be neither that species nor *H. immutabile*. On the other hand his *H. trapezoideum* is on leaves of *Populus* as was Fuckel's type of *H. immutabile;* this, to be sure, is of doubtful significance, but his drawings show the characteristically shaped spores of the latter and leave little doubt that *H. trapezoideum* Vel. is referable to synonymy under *H. immutabile* Fuckel.

Sydow's Mycotheca Marchica *678* labeled *H. epiphyllum* (Pers.) Fr. var. *candidum* Karst. is cited above as *H. immutabile* since it is in complete agreement with the type of the latter. It is possible that it also correctly represents Karsten's variety, but no authentic material is available for comparison. The specimen reported from Quebec (Mycologia **31:** 730) as *H. immutabile* appears inseparable from *H. epiphyllum* though it has smaller spores. A Michigan collection sent me by Dr. Kanouse (A. H. Smith *32–103*) as *H. conformatum*, and presumably representative of, though not one of, the three collections reported under that name by her (Papers Michigan Acad. **19:** 97, 1934) has spores that are less regular in shape than those of *H. immutabile* and it also lacks croziers, otherwise it appears similar. Reports of "*H. conformatum* Karst." from China have not been investigated.

**4. Helotium contortum** White, sp. nov.

FIGURE 4.

Apotheciis sparsis, sessilibus, 2–5 (–7) mm. diam. in statu vegeto mollibus, carnosis, albis vel sordidis, hymenio convexo; apotheciis exsiccantibus tenuibus, 1–3 mm. diam., sordide-ochraceis, concavis; receptaculis levibus, complanatis basis latis adhesis; paraphysibus ad basem rectis vel 1-ramosis, ad apicem inaequabiliter breve-ramosis; ascis clavato-cylindricis, 70–90 x 8–9 μ; ascosporis uniseriatis vel biseriatis, obovatis, 8.5–12 x 4–4.5 μ.

**Apothecia** widely scattered or more rarely subgregarious, entirely sessile; when fresh 2–5 (–7) mm. diam., soft, fleshy, watery, dirty white to more typically dull dilute yellowish or brownish, all parts externally and internally exactly concolorous, the hymenium convex; on drying contracting to 1–3 mm., becoming thin, soiled-ochraceous, dish-shaped; **receptacle** entirely smooth, attached by a broad central portion from which a few whitish hyphae sometimes radiate superficially on the substratum, free toward the margin, turning away from the substrate on drying; **margin** in the fresh condition cuneate, even, directed outward and downward, on drying turning up, becoming inrolled; **in section** compact, homogeneous, composed throughout of large thin-walled isodiametric cells 15–30 μ diam. or up to 45 x 25 μ except in an intermediate zone just underneath the margin where they are narrower, elongate in the direction from base to margin forming a narrow layer of prosenchymatous tissue with globular cells on either side; **paraphyses** once- or twice-forked below the middle and with two or three very short

branches at the immediate apex, the tips scarcely or not at all enlarged; **asci** clavate-cylindric, 70–90 x 8–9 $\mu$, originating from croziers; **ascospores** irregularly uniseriate or biseriate, obovoid, 1-celled, 8.5–12 x 4–4.5 $\mu$, the content not granular.

HABITAT: Apothecia arising from the veins and parenchyma of water-saturated leaves of *Acer* sp. and *Alnus* sp. in low wooded swamps.

DISTRIBUTION: New York and Michigan. June 14–July 10.

MATERIAL EXAMINED: **N. Y.:** Labrador Lake, on *Acer*, July 10, 1937, *Whetzel, Viegas, & White* (FH). — **Mich.:** Au Train Lake, Au Train, on *Alnus*, June 14, 1933, *A. H. Smith 33–476*, **type** (OTB).

The species is characterized by the rather large, broadly sessile, fleshy apothecia which contract and become more or less distorted on drying, the branched paraphyses, and the pseudoparenchymatous structure of the disc tissue.

5. **Helotium Conocarpi** Seaver & Waterston, Mycologia **34:** 517, *fig. 1, upper.* 1942.

FIGURE 5.

**Apothecia** scattered to subgregarious, erumpent, when young and in the dried condition, smooth, shiny, nearly black, subglobose and subsessile and opening by a minute apical pore, later expanding, becoming discoid, substipitate, fleshy, and at maturity dark brown to the naked eye, 0.5–0.8 mm. diameter (up to 3 mm. fide Seaver, perhaps when fresh); **stipe** stout, scarcely more than a papilla, rarely cylindric and distinct, barely raising the receptacle off the substratum, close to "Cinnamon Brown" (R); **receptacle** marked and colored like the stipe, becoming smooth and much darker toward the margin at least when dry; **margin** in dried material smooth, entire, tumid and upturned until complete maturity then approximately even with the hymenium; **hymenium** with a delicate lilac tint (Seaver) when fresh ?, dark brown when dried; **in section** the hymenium about 75 $\mu$ thick, the exposed surface brown due to color in the tips of the paraphyses; **hypothecium** scarcely distinct; **medullary** region composed of thin-walled, short-celled hyphae compact and parallel in the region of the stipe, directed outward and upward toward the margin and loosely interwoven in the subhymenium; **ectal excipulum** distinct about 50 $\mu$ thick at the base, tapering to 25 $\mu$ at the margin, composed of isodiametric cells 5–14 $\mu$ diameter, compact, with walls scarcely thickened and very slightly gelatinously modified, the outer exposed cells brownish and rather uneven thus imparting the furfuraceous external surface; **paraphyses** simple or once or twice forked at or below the middle, clavate-enlarged at the apex, longer than the asci, 3–4.5 $\mu$ diam., distinctly brown; **asci** clavate-cylindric, 55–65 x 7–8 $\mu$, not originating from croziers; **ascospores** biseriate or sub-biseriate, more rarely in one row, obovoid, 7.5–10 x 3.3–4 $\mu$, the content not granular.

HABITAT: On dead leaves of *Conocarpus erectus* L.

DISTRIBUTION: Bermuda.

MATERIAL EXAMINED: St. David's Island, Dec. 7, 1940, *F. J. Seaver & J. M. Waterston* (FH).

The description presented above is based on that of Seaver, together with an examination of a portion of one of his two original collections (cited by him as *375* and *425*), which he kindly sent me, and which has been deposited in the Farlow Herbarium. In his letter to me, Dr. Seaver questioned his published generic disposition of this species. I also would question it: the dark brown color, coriaceous texture, and colored paraphyses preclude its acceptance in *Helotium*, even in the all-inclusive sense in which I am treating that genus at the present time; and these same characters place it in the Ciborioideae in the vicinity of *Rutstroemia* and *Pycnopeziza*. It should eventually find a place in *Pycnopeziza* (see White & Whetzel, Mycologia **30:** 187–203, *fig. 1–21.* 1938; also Whetzel & White, Mycologia **32:** 609–620. 1940), where it differs only in minor characters from *P. pachyderma*, occurring on the fallen leaves of various trees in North America and Europe, and from *P. Sejournei*, occurring on the leaves of *Hedera Helix* L. in central Europe. The brown paraphyses and perhaps the darker color separate it from both *P. pachyderma* and *P. Sejournei*, and from the latter it is further distinct in its smaller asci and spores.

Sections demonstrate definitely that there is no trace of a stroma in the leaf tissue, and careful search fails to reveal any conidial stage or spermatia. Study of the species in pure culture is desirable.

**6. Helotium translucens** sp. nov.

FIGURE 6.

Apotheciis sparsis vel subgregariis, stipitatis, subcarnosis, subhyalinis in statu vegeto, dum autem exsiccantibus albido-discoloribus vel pallide ochraceis, usque ad 0.3 mm. altis ac disco 0.3–0.4 mm. diam., in statu sicco, colore eodem fere gaudentibus, in statu vegeto et exsiccato, haud plicatis neque distortis; stipite distincto sed brevi, mediocriter crasso, cylindraceo, levi, stricto, abrupte in discum dilatato; disco crasso; receptaculo levi; hymenio pori ope aperto, mox applanato et exsiccante persistenter plano; paraphysibus leviter clavato-dilatatis, ad apicem 3–3.5 μ diam.; ascis cylindraceo-clavatis, 75–95 x 10–11.5 μ, poro iodi ope caerulescente; ascosporis uni-seriatis vel sub-biseriatis dispositis, obovatis, unicellularibus, 12–15 x 4–4.5 μ, intus vix vel non granulatis.

**Apothecia** scattered to subgregarious, stipitate, subfleshy, practically hyaline when fresh, drying discolored-whitish to pale ochraceous, up to 0.3 mm. high and 0.3 to rarely 0.4 mm. across the disc when dry, of about same color and consistency on all parts in both fresh and dried condition, not wrinkled or distorted on drying; **stipe** distinct though short, of medium thickness, cylindric, smooth, straight, expanding abruptly into the disc; **disc** thick; **receptacle** smooth; **hymenium** opening by a pore, soon plane, remaining plane on drying; **paraphyses** slightly clavate-enlarged, 3–3.5 μ diam.; **asci** cylindric-clavate, the thickness carried well down toward the base and rather abruptly narrowed at the septum, 75–95 x 10–11.5 μ, the pore blue with iodine; **ascospores** uniseriate to

sub-biseriate, obovoid, 1-celled, 12–15 x 4–4.5 $\mu$, the content scarcely or not at all granular.

HABITAT: Apothecia arising from the parenchyma, lateral- and net-veins of leaves of *Acer* sp. and *Quercus* sp.

DISTRIBUTION: Massachusetts. November.

MATERIAL EXAMINED: On decaying leaves of *Acer* sp., swamp at east side of Great Blue Hills, near Milton, Nov. 11, 1941, *Linder, Seeler, & White*, **type** (FH). — A second collection, same substrate, etc., *White* (FH). — On fallen leaves *Quercus*, Stony Brook Reservation, West Roxbury, Nov. 11, 1941, *White* (FH).

In habitat and in color and consistency of the apothecia *Helotium translucens* is somewhat similar to *H. caudatum* (Karst.) Vel., but it differs in occurring later in the season, being smaller in size though more fleshy, and in having smaller asci and smaller and differently shaped spores. The apothecia in the dried condition are somewhat lighter in color than the surface of the leaves on which they occur, yet not strikingly so, which together with their small size renders them practically invisible to the unaided eye. The spores are similar to those of *H. immutabile*.

7. **Helotium fastidiosum** Pack, Ann. Rep. New York St. Mus. **27** (1873): 107. 1875. — Sacc., Syll. Fung. **8**: 221. 1889. — Mains, Mycologia **31**: 730. 1939. — White, Mycologia **34**: 165–168, *fig. 6–9*. 1942.
*Calycina fastidiosa* (Peck) Kuntze, Rev. Gen. Pl. $3^2$: 448. 1898.

FIGURE 7.

**Apothecia** small, slender, delicate, stipitate, 1–1.5 or rarely 3 mm. high, 0.8–1.5 mm. across the disc; **stipe** very slender, subcylindric, smooth, dilute white to practically hyaline, sometimes more or less discolored toward the base, thickened slightly just below the disc, expanding abruptly into disc, not changing on drying except for a deepening of the color to a hyaline-yellow or pale creamy yellow, sometimes becoming pale ochraceous especially on the lower portion; **disc** flat-expanded at maturity, medium thin; **receptacle** smooth, dilute white to whitish-yellow, rarely varying to pale ochraceous with age, not changing on drying except for a slight deepening of color; **hymenium** slightly convex with maximum moisture content, opaque, white or more often pale yellow, on drying becoming plane to saucer-shaped, waxy, the color deepening somewhat to pale or bright yellow, approximating "Apricot Yellow" (R), or more rarely as dark as "Deep Chrome"; **paraphyses** simple, slightly or not at all enlarged at apex, 2.5–3.5 $\mu$ diam.; **asci** not originating from croziers, clavate, 80–100 x 9–12 $\mu$; **ascospores** elongate, clavate, slightly curved and rounded at the upper end, straight and pointed below, 26–36 x 3.5–4.5 $\mu$, biseriate, each containing a single row of from 6–10 oil globules.

HABITAT: On petioles and midveins of decaying leaves of *Alnus incana* (L.) Moench., *Alnus* sp., and decaying catkins of indet. species, probably *Alnus*.

DISTRIBUTION: Quebec, New York, and Oregon. Aug.–Sept.

MATERIAL EXAMINED: See Mycologia **34**: 167. 1942.

In general aspect it is similar to the several species following, but the long spores distinguish it easily from all other known foliicolous forms.

**8. Helotium caudatum** (Karst.) Vel., Monogr. Discom. Bohem. **1**: 206, *pl. 20, fig. 35.* 1934.

*Peziza caudata* Karst., Fungi Fenn. Exsicc. *547.* 1866. — Karst., Not. Soc. Fauna Fl. Fenn. **10**: 144. 1869.

*Helotium scutula* (Pers. ex Fr.) Karst. var *caudatum* (Karst.) Karst., Not. Soc. Fauna Fl. Fenn. **11**: 234. 1871. — Karst., Bidr. t. Kännedom af Finl. Nat. o. Folk **19**: 112. 1871. — Migula *in* Thomé's Krypt.-Fl. **3**: 1200. 1913.

*Helotium naviculasporum* Ellis, Bull. Torrey Club **5**: 46. 1874. — Cooke, Bull. Buffalo Soc. Nat. Hist. **2**: 299. 1875. — Sacc., Syll. Fung. **8**: 211. 1889. — Ellis, Cat. Pl. New Jersey, p. 551. 1890. — Rehm *in* Rabenh. Krypt.-Fl. $1^3$: 780. 1893. — White, Mycologia **34**: 169, *fig. 3, 11.* 1942.

*Helotium saprophyllum* Cooke & Peck *in* Peck, Ann. Rep. New York St. Mus. **29** (1875): 55. 1878. — *Nom. nud.* Cooke, Bull. Buffalo Soc. $3^1$: 23. 1875. Sacc., Syll. Fung. **8**: 227. 1889. — [Mycologia **33**: 573. 1941.]

*Calycina naviculaspora* (Ellis) Kuntze, Rev. Gen. Pl. $3^2$: 448. 1898.

*Calycina saprophylla* (Cooke & Peck) Kuntze, Rev. Gen. Pl. $3^2$: 449. 1898.

*Helotium sparsum* Boud., Hist. Classif. Discom. Eur., p. 111. 1907. — Boud., Icones Myc. *pl. 495.* 1905–10. — Rea, Brit. Myc. Soc. Trans. **4**: 317, *pl. 9.* 1913. — Ramsb., Brit. Myc. Soc. Trans. **4**: 373. 1913. — Sacc., Syll. Fung. **22**: 649. 1913. — Kanouse, Papers Michigan Acad. **22** (1936): 119. 1937.

*Phialea phyllophila* (Desm.) Gill. var. *Jaapii* Rehm ex Jaap, Abh. Bot. Ver. Prov. Brandenburg **49**: 10. 1907. — Sacc., Syll. Fung. **22**: 655. 1913.

FIGURE 8.

**Apothecia** scattered, sparse, delicate, slender-stipitate, hyaline-white when fresh, becoming opaque and more or less yellowish or pale ochraceous on drying, reaching a height of 0.75–1.5 mm. and a diameter across the disc of 0.4–1.3 mm.; **stipe** slender, delicate, smooth, dilute white when fresh, sometimes yellowish at the substratum, drying semi-opaque and white to creamy yellow; **disc** at first elongate, thick, the outside wine-glass shaped, plane, then expanding, at maturity of medium thickness, emarginate; **receptacle** smooth, hyaline to dilute white when fresh, drying opaque and yellowish; **hymenium** plane from the very young stages to complete maturity, finally somewhat convex with maximum moisture content, tender, white, more opaque than stipe and receptacle, drying waxy and pale yellow to ochraceous, remaining plane or nearly so; **paraphyses** simple, slightly or not at all enlarged at apex, 2–3 $\mu$ diam.; **asci** clavate, not or very rarely originating from croziers, 85–95 (–110) x 8–11 $\mu$; **ascospores** elongate, slightly curved, obtuse above, more or less pointed at the lower end, 18–25 x 4.5–5.5 $\mu$, typically more or less filled with irregular refractive granules, sub-biseriate.

HABITAT: On fallen decaying leaves, the apothecia usually originating from the midrib or veins, more rarely from petioles or parenchyma of the leaf blade. American specimens on *Acer* sp., *Alnus incana* (L.) Moench, *Carya* sp., *Fagus grandifolia* Ehrh., ? *Prunus* sp., and *Tilia*

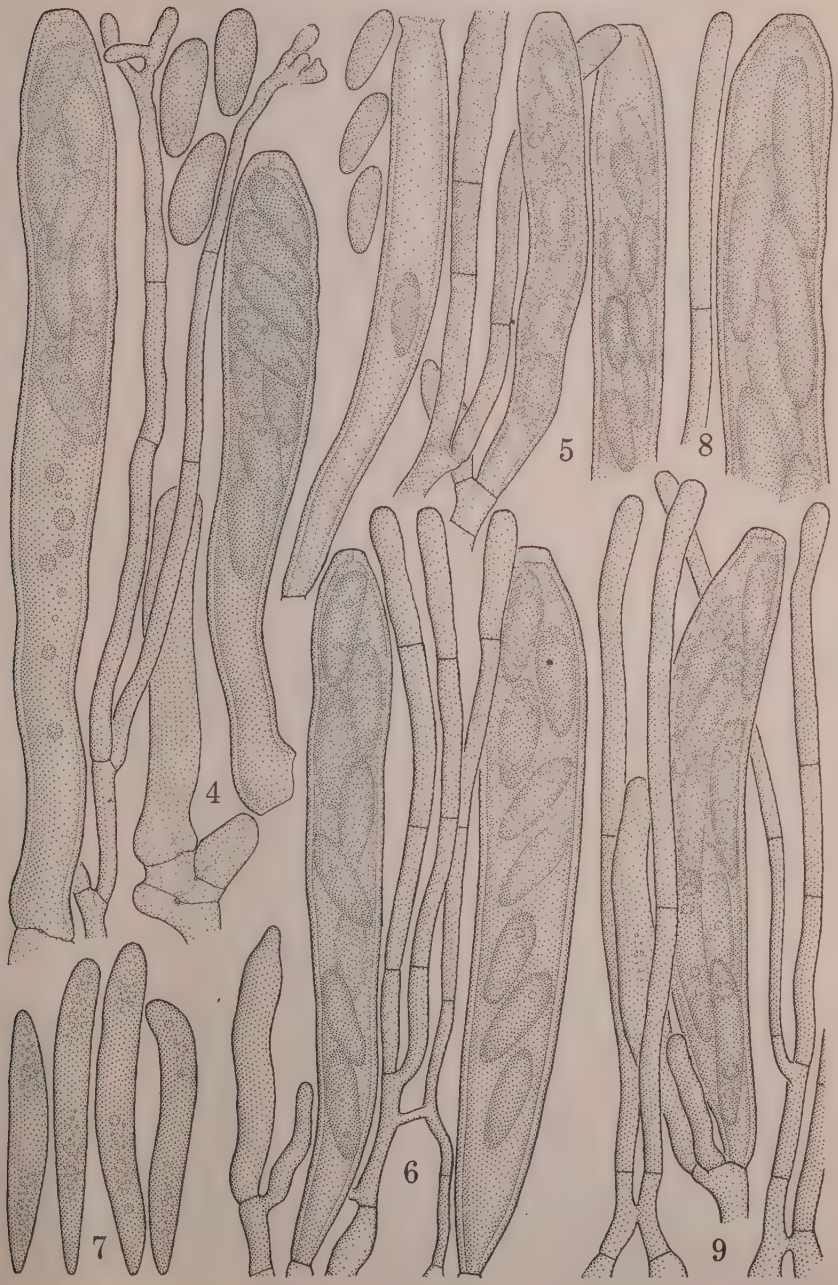
*americana* L.; listed from Europe on *Acer campestris*, *Alnus glutinosa*, *Alnus* sp., *Betula* sp., *Corylus* sp., *Carpinus* sp., *Fagus sylvatica*, *Fagus* sp., *Populus alba*, *P. canadensis*, *P. canescens*, *P. tremuloides*, *Populus* sp., *Quercus* sp., and *Salix* sp. I have observed it frequently in the vicinity of Ithaca, New York, where it appears to be confined to low moist woods and swampy areas in which the leaves are wet or at least moist most of the time; alder swamps are a favorite habitat.

DISTRIBUTION: Common in New York from July through September, also found in New Jersey, Michigan, and Ohio; common in Europe where it is known from Finland, Czechoslovakia, Germany, France, and England.

MATERIAL EXAMINED: **North America: N. Y.** (All as *Helotium saprophyllum*): Lake Pleasant, on maple leaves, *Peck*, type of *H. saprophyllum* (CUP-D *5987*, NYS). — Indian Lake, August, *Peck* (CUP-D *5989*, NYS). — Adirondack Mts., *Peck* (CUP-D *5990*, NYS). — Lowville, on fallen leaves *Tilia americana*. Sept., *Peck* (NYS). — Sand Lake, July, *Peck* (CUP-D *5832*). — Ridgway, Orleans Co., on dead leaves in woods, 1904, *C. E. Fairman* (CUP-D *462*, NYS). — Lloyd Preserve, McLean, on decaying leaves *Alnus incana*, Oct. 20, 1935, *White & Whetzel* (FH). — Old Forge, Adirondack Mts., on fallen leaves *? Prunus*, Sept. 3, 1936 (CUP *25515*, FH) — Labrador Lake, on decaying leaves, mostly *Acer*, in wooded swamp, July 10, 1937, *White*, *2981* (FH). — On *Carya*, midribs, lateral and net veins of leaves in good state of preservation, Sept. 14, 1938, *Whetzel*, *White*, & *Sproston* [Atypical spores] (CUP *27890*, FH, US). — Little Ravine, below Newfield, on petioles, midribs, lateral & net veins of well decayed leaves of *? Ulmus*, Sept. 14, 1938, *Whetzel* & *White* (CUP *27891*, FH). — **N. J.** (All as *Helotium naviculasporum*): "Ad folia putrescentia Aceris." Ell., Fungi Nov.-Caes. *53* (NY). — Newfield, on maple leaves on wet ground, Ell., N. A. F. *62* (CUP-D *2972*, NY). — Newfield, on old leaves decaying in stagnant water, 23 June, 1876, *Ellis* (CUP-D *8465*). — Newfield, on decaying leaves lying on wet ground in swamp, July, 1876, *Ellis* (FH). — **Mich.:** Marquette, on decaying leaves. 9–10–34, *E. B. Mains 34–144*, as *H. sparsum* (FH). — **Ohio:** Preston, 1902, *A. P. Morgan* [as *H. phyllophilum*] (CUP-D *2126*). — **Europe: Finland:** "Mustiala, pa formultnande aspblad, Okt. 1865." Karst., Fungi Fenn. Exsicc. *547*, **type** of *Peziza caudata* (FH). — **Germany:** "An Spiraea Blättern," Berlin, Steglitz. 10.1892, *Sydow*, Myc. March. *3772* [as *H. sordidatum*] (FH). — "An Alnus glutinosa." Berlin, Wannsee, 10.1892, *Sydow*, Myc. March. *3768* [as *H. phyllophilum*] (FH). — "An Populus alba," Berlin, Lichterfelde, 10.1892. *Sydow*, Myc. March. *3770* [as *H. phyllophilum*] (FH). — "Auf *Fagus sylvatica*." Steglitz bei Berlin, 6.1893, *Sydow*, Myc. March. *4163* [as *H. phyllophilum*] (FH). — "Auf Alnus glutinosa." Berlin, Wilmersdorf, 11.1895. *Sydow*, Myc. March. *4437* [as *H. phyllophilum* f. *albescens*] (FH). — "Auf Populus canescens." Berlin, Thiergarten, 11.1895, *Sydow*, Myc. March. *4438* [as *H. phyllophilum*] (FH). — "Pappelblattern." Prater, Wien, 16/X/1901, *Von Höhnel* [as *H. phyllophilum*] (FH-H). — "Auf den Nerven faulender Blätter von Populus canadensis Michx. Prov. Brandenburg: Triglitz in der Prignitz." 10.X.1905, *Jaap*, Fungi Sel. Exsicc. *152* type of *Phialea phyllophila* var. *Jaapii* (FH). — **France:** "Feuille et petioles Alnus." Env. le Rouen, 8–1889 [as *Helotium scutula* var. *albida*] (FH-P).

Taxonomically this is one of the more difficult members of the genus, differing from its neighbors in characters which are for the most part a

**Fig. 4–9: 4,** *Helotium contortum*, from type (OTB); **5,** *H. Conocarpi*, from spec. cited (FH); **6,** *H. translucens*, from type (FH); **7,** *H. fastidiosum*, from type (CUP-D *5948*); **9,** *H. Linderi*, from type (FH). Fig. 4 × 1500 approx.; all others × 1290.




FIGURES 4–9.

matter of degree and not to be considered very reliable. First of all it is doubtfully distinct from *H. scutula* (Pers. ex. Fr.) Karst., which is common and widely distributed on dead herbaceous stems; while generally more delicate and less deeply colored than the latter, it appears difficult nevertheless to find any morphological characters (cf. White, Mycologia **34:** 158, *fig. 1–3*, 166, *fig. 6, 11.* 1942) on which to make a really meaningful distinction, and the separation here maintained, for the present at least, is largely arbitrary, those forms on leaves being referred to *H. caudatum* and those on herbaceous stems to *H. scutula.* The larger spores appear to separate *H. caudatum* sufficiently from *H. albidum* (Rob. ex Desm.) Pat. & *H. albopunctum* Peck. The beautiful and very ample material of Petrak, Fl. Bohem. Morav. Exsicc. *236* issued as *H. caudatum* has spores that are rather small for that species and is reserved for further study.

**9. Helotium Linderi** sp. nov.

FIGURE 9.

Apotheciis dispersis, sparsis, stipitatis, ad 1.5 mm. altis, disco circa 1 mm. diam., in statu vegeto albis, discis exsiccantibus cinereis vel nigrescentibus; stipitibus gracilibus, exsiccantibus hyalinis ochraceis, levibus, sublucidis; discis subcarnosis, poris apertis, obpiriformibus, expansis; receptaculis levibus, hyalinis, in statu vegeto ochraceis, cinereis vel subnigrescentibus; hymenio plano, exsiccante nigrescente et subconcavo; paraphysibus simplicibus vel ad basem ramosis, subclavatis, circe 3 μ diam.; ascis clavatis, 65–75 x 9–10 μ; crozier nul; ascosporis biseriatim dispositis, elongatis, subclavatis, leviter curvatis, guttulis 3–6.

**Apothecia** scattered, sparse, stipitate, up to 1.5 mm. high and about 1 mm. across the disc, pure white when fresh, the disc becoming cinereous to nearly black on drying; **stipe** slender, white when fresh, drying hyaline-ochraceous, smooth, sub-shiney, slightly thickened just below the disc; **disc** rather thick, opening by a pore, obpiriform, expanding; **receptacle** smooth, translucent white when fresh, smooth, drying ochraceous to cinereous or nearly black; **hymenium** finally plane, white, drying darker than the receptacle, often nearly black, and becoming somewhat concave; **paraphyses** simple or once forked below the middle; scarcely enlarged at the apex, about 3 μ diam.; **asci** clavate, 65–75 x 9–10 μ, not originating from croziers; **ascospores** biseriate, elongate, narrowed toward the lower end, larger and rounded and sometimes curved above, 16–18 x 3.5–3.9 μ, containing 3–6 oil globules.

HABITAT: On fallen leaves of *Betula* sp. and sp. indet.

DISTRIBUTION: Known only from Tennessee and Wisconsin.

MATERIAL EXAMINED: **Tenn.:** On fallen leaves, Chimney Trail, Great Smoky Mt. Nat. Park, elev. 3200 ft., Aug. 18, 1939, **type,** *D. H. Linder* (FH). — On fallen birch leaves, moist brook bed, Indian Gap, Great Smoky Mt. Nat. Forest, Aug. 20, 1939, *D. H. Linder* (FH). — **Wisc.:** Blue Mounds, 8–1–08 (Univ. Wisc.-Herb., *R. A. & A. M. Harper 410*).

Differs from all the other slender-stipitate species in that the hymenium and upper part of the receptacle becomes dark on drying — varying from

cinereous to brownish or nearly black — commonly about the color of the pore surface of *Polyporus adustus* (Willd.) Fr.

The two Tennessee specimens recorded above appeared in the report of the 1939 foray as *Helotium saprophyllum* (Mycologia 33: 573. 1941).

The Wisconsin specimen appears to be the basis of the record by Dodge (Trans. Wisconsin Acad. **27**: 1035. 1914) under the name of *H. sordidatum* Karst. No material of the latter is available for comparison, but that it does represent that species is extremely doubtful.

**10. Helotium albopunctum** Peck, Ann. Rep. New York St. Mus. **31** (1877): 47. 1879; non (Desm.) Bucknall, Bristol Nat. Soc. Proc. **3**: 137. 1882. — White, Mycologia **34**: 172, *fig. 13.* 1942.

*Pezizella albopuncta* (Peck) Sacc., Syll. Fung. **8**: 276. 1889. — [Cummins, Papers Michigan Acad. **11** (1929): 111. 1930].

*Hymenoscypha albopuncta* (Peck) Kuntze, Rev. Gen. Pl. **3**²: 485. 1898.

FIGURE 10.

**Apothecia** scattered, not numerous, sometimes subgregarious in groups of two to five, usually not more than five on a single leaf, rarely rather abundant, very small, slender, delicate, stipitate, up to 1 mm. high and 0.8 mm. diam. across the disc, usually smaller, when fresh creamy-white to yellowish-stained, drying ochraceous-yellow, all parts approximately concolorous, waxy-cartilaginous when dried; **stipe** very slender, smooth, sub-shiny, sometimes very short, commonly about twice as long as the diameter of the disc; **disc** rather thick; **receptacle** smooth, when dried sub-shiny and not wrinkled; **hymenium** plane from the earliest stages to complete maturity, not changing shape on drying; **margin** obtuse, circular, even, not elevated above the hymenium in the fresh condition, rarely very slightly so on drying; **paraphyses** simple or more often once or twice branched at or below the middle, clavately enlarged at the apex, 2.5–3.8 $\mu$ diameter; **asci** 60–70 x 8–10 $\mu$, not originating from croziers; **ascospores** biseriate, mostly lying parallel with ascus, 14–16 x 3.2–4 $\mu$, oblong, flattened on one side, straight or slightly curved, rounded above and sometimes bent abruptly to one side, obtusely-pointed at the lower end, always 1-celled, containing when fresh 2–4 conspicuous oil drops, these usually irregularly contracted in old herbarium specimens or sometimes breaking up to form several smaller, scattered, refractive granules.

HABITAT: Apothecia arising from the parenchyma tissue, or less frequently also from the lateral and mid-veins of fallen leaves of *Fagus grandifolia* Ehrh.

DISTRIBUTION: New York, West Virginia, Virginia, and Georgia. A mid- to late summer species.

MATERIAL EXAMINED: **N. Y.:** Adirondack Mts., *Peck*, **type** (CUP-D *5915*, NY, NYS). — Fall Creek, Ithaca, Aug. 8, 1895, *Durand* [as *Helotium phyllogenon* on oak leaves] (CUP-D *921*). — Same locality. etc. [as *H. phyllogenon* on *Carpinus*(?)] (CUP-D *922*). — Labrador Lake, near Tully, Aug. 26, 1935, *Whetzel & White* (CU-P *24821*, FH). — Labrador Lake. Aug. 12, 1936, *Whetzel & White 2555* (CU-P *25464*, FH). —

Labrador Lake, Aug. 12, 1936, *Whetzel & White 2613* (FH).—**W. Va.:** Albright, Aug. 4, 1908, *J. L. Sheldon* [as *H. phyllophilum*] (CUP-D *6502*).—**Va.:** Laing Trail near Mt. Lake, Sept. 3, 1936, *J. A. Stevenson & W. W. Diehl* [as *Phialea phyllophila* (Desm.) Gill. f. *fagicola* Sacc.] (BPI, FH).—Cascades, near Mt. Lake, Sept. 4, 1936, *E. K. Cash* [as *Phialea phyllophila* (Desm.) Gill. f. *fagicola* Sacc.] (BPI).—**Ga.:** Bobbin Mill, Athens, July 13, 1940. *J. H. Miller.* [as *Phialea phyllophila* (Desm.) Gill. f. *fagicola* Sacc.] (BPI).

Additional work on the foliicolous forms since the publication of my paper covering the Peck species, demonstrates that *Helotium albopunctum* is fundamentally a stipitate species. Peck notes of the type: "The stem is so short that the plant appears sessile." On the basis of this statement, together with an examination of Peck's specimen which had given satisfactory evidence of its accuracy, I had previously formed a conception of *H. albopunctum* as a sessile form. It was largely this that prevented the identification of later collections cited above with Peck's species, even though some of them had been studied prior to the preparation of the previous paper. In the type there are scarcely any apothecia with stipes more than 0.1 mm. long. The single Georgia specimen cited agrees in this respect. However, in all the others they range generally from 0.2–0.8 mm., with only a very exceptional one as short as the longest in the type.

The West Virginia specimen cited was incorrectly reported in a list by Millspaugh (W. Va. Geol. Surv. **5** (A): 111. 1913) as *H. phyllophilum*. The Virginia material (comm. Miss Cash) was listed among the 1937 foray collections (Mycologia **29:** 372. 1937) as *Phialea phyllophila* f. *fagicola*, and the Georgia collection (also comm. Miss Cash) was reported by Miller (Pl. Dis. Rep., Suppl. 131: 47. 1941) under the same name. Saccardo's forma *fagicola* is unknown to me; it may be a synonym of Peck's *albopunctum*.

There appears to be only one previous literature record under Peck's name and based on material other than the original: It was reported by Cummins (l. c.) on leaves of ? *Cornus* from Montana. This specimen has been loaned me by Miss Kanouse, and it proves to be entirely foreign to *Helotium*, though I am unable to place it.

**11. Helotium phyllogenon** Rehm, Hedwigia **24:** 14. 1885.—Massee, Brit. Fung.-Fl. **4:** 258. 1895.—Boud., Hist. Classif. Discom. Eur., p. 112. 1907.—Ramsb., Brit. Myc. Soc. Trans. **4:** 373. 1913.—Gola, Cat. Erb. Mic. Sacc., p. 120. 1930.
*Peziza epiphylla* Pers. ex Fr. var. *populina* Lasch ex Rabenh., Flora **38:** 267. 1855.
*Phialea phyllogena* (Rehm) Sacc., Syll. Fung. **8:** 274. 1889.
*Hymenoscypha phyllogena* (Rehm) Kuntze, Rev. Gen. Pl. $3^2$: 485. 1898.
*Helotium phyllophilum* auct. non (Desm.) Fr.—Rehm *in* Rabenh., Krypt.-Fl. $1^3$: 796. 1893.—Migula *in* Thomé's Krypt.-Fl. $10^2$: 1203. 1913.

FIGURE 11.

**Apothecia** known only in the dried condition, scattered, solitary, not numerous, delicate, slender-stipitate, ochraceous yellow, all parts more or less concolorous, reaching a height of 1.5 mm. and a diameter across

the disc of 0.5 mm., on moistening reviving fully and becoming entirely colorless; **stipe** very slender, delicate, cylindric, smooth, flexuous when long, slightly wrinkled; **disc** at first piriform, opening by a pore, later flat-expanded, of medium thickness; **receptacle** smooth, concolorous with stipe; **hymenium** saucer-shaped, waxy, concolorous with receptacle or varying toward reddish or brownish, becoming plane on moistening; margin subacute, the sterile tissue not extending above the asci, or at other times very slightly so and abruptly acute; **paraphyses** once-forked near the base, very slightly clavate above, 3–3.5 $\mu$ diam.; **asci** clavate-cylindric, rather broad at both base and apex, 65–75 x 8.5–11 $\mu$, not arising from croziers, the pore blue in iodine; **ascospores** uniseriate to sub-biseriate, narrow oblong-ellipsoid, 11–14 x 3.8–5 $\mu$, never septate, the content homogeneous, not granular or containing oil globules.

HABITAT: Apothecia arising from net veins or occasionally lateral veins of leaves of *Populus*, reported on *P. nigra* L. and *Populus* sp. A fall species — October (Hungary) and November 1 (Austria). Rehm (l. c., p. 797) mentions a German collection on beech leaves; this probably is a misdetermination.

DISTRIBUTION: Material studied from Germany, Austria, and Hungary; reported from England by Massee.

MATERIAL EXAMINED: **Germany:** "Ad folia putrida Populi nigrae pr. Dreisen." 1854, Rabenh., Klotz. Herb. Myc. *1920*, Type of *Peziza epiphylla* var. *populina* (FH). — **Austria:** Prater, Heustadlwasser, 1 Nov. 1902, *Von Höhnel* [as *Helotium phyllophilum*] (FH-H). — **Hungary:** "An faulenden Pappel-Blättern bei Ungarisch-Altenburg (Ungarn)." 10/1883, *Linhart*, Rehm, Ascom. *768*, **type** of *H. phyllogenon* (FH).

It does not appear possible to separate this species on external morphological characters from *H. phyllophilum* (Desm.) Rehm, *H. albopunctum* Peck, *H. caudatum* (Karst.) Vel., or *H. fastidiosum* Peck. They all have distinctive spore characters and these, along with substratum and geographic range, should enable one to place a given specimen without too much difficulty; the contrasting characters are indicated in the key.

Rehm's conception of *H. phyllophilum* (Desm.) Karst. appears to be based largely, if not entirely, on his own *H. phyllogenon;* the latter he refers incorrectly to synonymy under the former. It appears further that Rehm was more or less generally confused with regard to these two species and certain similar or related forms. For example, he cites Ascom. *768*, type of *H. phyllogenon*, and also Linh., Fungi Hung. *386* as both representing "Sehr schöne Exemplare . . ." of *H. phyllophilum;* his Ascom. *768* (FH) typifies *H. phyllogenon* as a good species, and Linhart's *386* (FH) represents *H. caudatum* (Karst.) Vel.

Two specimens in the Durand Herbarium as *H. phyllogenon* (*921*, *922*), both taken on beech leaves at Ithaca, represent instead *H. albopunctum* Peck.

**12. Helotium phyllophilum** (Desm.) Fr., Summa Veg. Scand., p. 356. 1849. — Karst., Symb. Myc. Fenn., Not. Fauna Fl. Fenn. **11**: 239. 1870. — [Sacc.,

Michelia **1**: 442. 1878]. — [Phill., Man. Brit. Discom., p. 162. 1887]. — [Massee, Brit. Fung.-Fl. **4**: 257. 1895]. — [Rehm *in* Rabenh., Krypt.-Fl. $1^3$: 796. 1893. — [Massee & Crossl., Fung. Fl. Yorkshire, p. 285. 1905]. — Boud., Hist. Classif. Discom. Eur., p. 111. 1907. — [Millspaugh, West Virginia Geol. Surv. **5**(A): 111. 1913]. — [Ramsb., Brit. Mycol. Soc. Trans. **4**: 373. 1913]. — [Dodge, Journ. Wisc. Acad. **17**: 1035. 1914]. — [Vel., Monogr. Discom. Bohem. **1**: 205. 1934]. — [Mycologia **31**: 730. 1939]. — [*Ibid.* **33**: 573. 1941].

*Peziza phyllophila* Desm., Pl. Crypt. France, ed. 1, *1159*. 1842; Ann. Sci. Nat. 2: **17**: 96. 1842. — Str., Nom. Fung., p. 431. 1862.

*Phialea phyllophila* (Desm.) Gill., Champ. France, Discom., p. 105. 1869. — Sacc., Syll. Fung. **8**: 254. 1889. — Oud., Ned. Kruidk. Archief. 3: $2^1$: 208. 1902. — Oud., Champ. Pays-Bas, p. 345. 1904. — [Mycologia **29**: 372. 1937].

*Pezicula phyllophila* (Desm.) Karst., Myc. Fenn. *pars prima*, Bidr. t. Känn. af. Finl. Nat. o. Folk **19**: 167. 1871.

*Hymenoscypha phyllophila* (Desm.) Kuntze, Rev. Gen. Pl. $3^2$: 485. 1898.

*Allophylaria phyllophila* (Desm.) Karst., Rev. Monogr., Acta Soc. Fauna Fl. Fenn. $2^6$: 131. 1885. — Nannf., Nova Acta Soc. Sci. Upsal. 4: $8^2$: 290. 1932.

FIGURE 12.

**Apothecia** scattered, very small, slender, stipitate, in the dried condition nearly the same color as the beech leaves on which they occur and scarcely visible to the unaided eye; when young consisting of a very slender subhyaline stalk, soon broadening at the top, clavate, then opening by a pore; **stipe** extremely slender, cylindric, delicate, smooth, yellowish-hyaline in the dried condition, not over 0.2 mm. long but, in relation to the size of the apothecium, of medium length, slender, and distinct; **disc** of same color and consistency throughout, at least so in dried specimens, hyaline-yellow, shiny, thin, cupulate to flat-expanded, reaching a diam. of 0.2 mm.; **paraphyses** simple, slightly or not at all clavate at the apex, about 3 $\mu$ diam.; **asci** arising from croziers, clavate, 65–75 x 8–9 $\mu$; **ascospores** biseriate, narrow oblong-fusoid, always distinctly 1-septate, 11.5–15 x 3.2–4 $\mu$, the ends rounded, the content homogeneous.

HABITAT: Apothecia arising from parenchyma, lateral- and mid-veins of both dorsal and ventral surfaces of leaves of *Fagus* sp. (also *Acer.* sp. ?).

DISTRIBUTION: France. Known with certainty only from the type, most, if not all, other reports being in error.

MATERIAL EXAMINED: "Hab. in foliis semiputridis Acerum et Fagorum." Desm., Pl. Crypt. Fr., **type** (FH, FH-C).

The portion of the original material which is in the Desmazières set at the Farlow Herbarium consists of two fairly large-sized leaves of *Fagus*, both in a good state of preservation. On both leaves the apothecia are fairly numerous; on one they are on the upper surface and on the other the lower surface. The apothecia are only slightly more yellowish than the surface of the leaf on which they occur, this together with their minuteness, rendering them nearly invisible to the unaided eye. Under a good binocular they are of a dilute yellow, tending toward hyaline, and all parts are of the same color and consistency. On being moistened

they become colorless or practically so. My conception of the species, and also the description presented above, are based entirely on this specimen, together with what appears to be a part of the same original collection in the Curtis herbarium. Its characteristic feature would appear to be its extreme minuteness, dilute color, and consistently 2-celled spores whose crosswalls are easily visible in ordinary KOH-phloxine preparations. Also, while too small for freehand sectioning, the disc in crushed mounts exhibits a large amount of tissue composed of hyphae with walls thickened and adherent, and the paraphyses appear to break easily, so that it is impossible to trace one from its base to its apex. Desmazières also indicates *Acer* as a substrate for the original material. No *Acer* leaves have been seen. It is possible that if some of the packets of the Desmazières number contain *Acer* leaves they will exhibit another species of Discomycete.

See also discussion under *Helotium albopunctum* and *H. phyllogenon*.

Eighteen herbarium specimens — all that have been available — under the name *phyllophilum* have been examined. Of these, eight represent *H. caudatum* (Karst.) Vel., four *H. albopunctum* Peck, three *H. populinum* Fuckel, two *H. epiphyllum* (Pers. ex Fr.) Karst., and one *H. phyllogenon* Rehm. These are as follows: Herb. Barb.-Boiss. *1381* (FH) = *H. populinum* — Syd., Myc. March. *3768* (FH) = *H. caudatum.* — Syd., Myc. March. *3769* = *H. populinum.* — Syd., Myc. March. *3770, 4163, 4437, 4438* (FH) = *H. caudatum.* —Tichener's Glen, Canandaigua, N. Y., Sept. 7, 1896 (CUP-D *916*) = *H. populinum.* — Enfield, N. Y., Oct. 19, 1901, as *H. phyllophilum fide* Rehm (CUP-D *1192*) = *H. epiphyllum* ? — Prater, Wien, 16/X.1901 (FH-H) = *H. caudatum.* — Coll. of 1/11/1902 (FH-H) = *H. phyllogenon.* — Preston, Ohio, 1902, *Morgan* (CUP-D *2126*) = *H. caudatum.* — Coll. of 1904. "Sudl. Wiener Bechen" (FH-H) = *H. caudatum.* — Albright, W. Va., Aug. 4, 1908, *Sheldon* (CUP-D *6502*) = *H. albopunctum.* — Duchesnay, Quebec (FH) = *H. epiphyllum.* — Three specimens comm. Miss Cash = *H. albopunctum.*

**13. Phialea Cassandrae** Kanouse, Papers Michigan Acad. Sci. **20**(1934): 71. 1935.

FIGURE 13.

**Apothecia** solitary, sparse, stipitate, slender, delicate, up to 2 mm. high when fresh, and up to 0.5 mm. across the disc; **stipe** extremely long and thin, in the dried condition flexuous, smooth, shiny, the lower half or more black, the upper part translucent-white, sub-bulbous at the base; **disc** in dried material thin, spreading at maturity, all parts concolorous with upper part of stipe, externally smooth, subshiny; **paraphyses** simple or more rarely once or twice forked at or near the base, clavate-cylindric or cylindric, thin-walled, rounded at the apex, about same length as the asci, with one or two crosswalls near the base, the long upper cell scarcely or not staining, 3–4.5 $\mu$ diameter; **asci** clavate,

30–42 x 5–7 $\mu$, the pore faintly blue with iodine; **ascospores** biseriate, oblong, more or less pointed below, 6–8 x 1.4–1.8 $\mu$, the content not granular.

HABITAT: On fallen leaves of *Chamaedaphne calyculata* (L.) Moench.

DISTRIBUTION: Michigan. Several collections with dates ranging from May 22 to June 17.

MATERIAL EXAMINED: Mud Lake Bog, Whitmore Lake, May 22, 1933, *A. H. Smith 33–82*, det. Kanouse, authentic (MICH.).

The description presented above is adapted from that of Dr. Kanouse (l. c.) together with an examination of the specimen cited, which she kindly loaned me. This and the preceding five species (nos. 5–12) appear to form a closely knit natural group, the small spores separating it at once from all the others. Its superficial appearance is similar to that of *H. Linderi*, but it is more slender and delicate, and the lower part of the stipe is black whereas in *H. Linderi* the disc is dark on drying and the base of the stipe white. It may be characterized as one of the most beautiful and distinct of species. Its gross characters are extreme slenderness and black stipe, and its microscopic characters the broad, cylindric paraphyses, the small asci proliferating abundantly from conspicuous croziers, and the small spores.

**14. Helotium populinum** Fuckel, Symb. Myc., p. 316. 1869. – Sacc., Syll. Fung. **8**: 247. 1889. — [Seaver, Mycologia **3**: 62. 1911].

? *Peziza punctiformis* Grev., Scot. Crypt. Fl. **2**: 63, *fig. 1–3*. 1824; non Pers., Syn. Meth. Fung., p. 674. 1801; non Fr., Syst. Myc. **2**: 105. 1822. — Str., Nom. Fung., p. 433. 1862. — (Under *Calycellina*) Nannf., Nova Acta Soc. Sci. Upsal. 4: **8**$^2$: 194, *pl. 10, fig. 4*. 1932.

*Helotium punctatum* Fr., Summa Veg. Scand., p. 356. 1849. — Berk., Outl. Brit. Fung., p. 372. 1860. — [Sacc., Fungi Ital., *fig. 1351*, 1883.] — [Sacc., Michelia **1**: 68. 1877.]

*Helotium Ilicis* Phill., Man. Brit. Discom., p. 164. 1887. — Sacc., Syll. Fung. **8**: 241. 1889. — Massee, Brit. Fung.-Fl. **4**: 260. 1895.

*Helotium punctiforme* (Grev.) Phill., Man. Brit. Discom., p. 168. 1887. — Massee, Brit. Fung.-Fl. **4**: 259. 1895. — Massee, Fung. Fl. Yorkshire, p. 285. 1905.

*Pseudohelotium punctiforme* (Grev.) Sacc., Syll. Fung. **8**: 295. 1889. — Oud., Champ. Pays-Bas, p. 347. 1904.

*Pezizella punctiformis* (Grev.) Rehm *in* Rabenh., Krypt.-Fl. **1**$^3$: 664. 1893. — Starb., Bihang till k. Vet.-Akad. Handl. **21**: 29. 1895. — [Kanouse, Papers Michigan Acad. **19** (1933): 96. 1934.] — Vel., Monogr. Discom. Bohem. **1**: 159; **2**: *pl. 10, fig. 16*. 1934.

*Pezizella tumidula* auct. — Rehn *in* Rabenh., Krypt.-Fl. **1**$^3$: 666, 650, *fig. 1–5*. 1893. — Von Höhn., Mitt. Bot. Techn. Hochsch. Wien **3**: 72, 105. 1926.

*Pezizella populina* (Fuckel) Rehm *in* Rabenh., Krypt.-Fl. **1**$^3$: 668. 1893. — [Von Höhn., Mitt. Bot. Techn. Hochsch. Wien **3**: 69. 1926.]

*Calycina Ilicis* (Phill.) Kuntze, Rev. Gen. Pl. **3**$^2$: 448. 1898.

*Calycina populina* (Fuckel) Kuntze, Rev. Gen. Pl. **3**$^2$: 448. 1898.

*Calycella Ilicis* (Phill.) Boud., Hist. Classif. Discom. Eur., p. 95. 1907. — Ramsb., Brit. Myc. Soc. Trans. **4**: 371. 1913.

*Hyaloscypha punctiformis* (Grev.) Boud., Hist. Classif. Discom. Eur., p. 126. 1907. — *Anon.*, Brit. Myc. Soc. Trans. **7**: 9. 1921.

*Micropodia populina* (Fuckel) Boud., Hist. Classif. Discom. Eur., p. 128. 1907.
*Hymenoscypha punctiformis* (Grev.) Schröt., Krypt.-Fl. Schlesien **3**²: 71. 1908. — Migula *in* Thomé's Krypt.-Fl. **10**²: 1151. 1913.
*Hymenoscypha populina* (Fuckel) Migula *in* Thomé's Krypt.-Fl. **10**²: 1152. 1913.
*Calycellina punctiformis* (Grev.) Höhn., [Sitzb. Akad. Wissensch. Wien, Math.-nat. Kl. 1: **127**: 601. 1918]. — [Von Höhn., Mitt. Bot. Techn. Hochsch. Wien **3**: 105. 1926.]
*Calycellina populina* (Fuckel) Höhn. [Sitzb. Akad. Wissensch. Wien, Math.-nat. Kl. 1: **127**: 601. 1918]. — [Von Höhn., Mitt. Bot. Techn. Hochsch. Wien **3**: 105. 1926.]
*Phialina puberula* auct. — Von Höhn., Mitt. Techn. Hochsch. Wien **3**: 106. 1926.

FIGURE 14.

**Apothecia** usually numerous, solitary or more rarely in groups of two or three, unevenly distributed over large portions of the substrate surface, tending in places to be gregarious; at first minute, globose, dirty yellowish-white when fresh, narrowed toward the base, enlarging, a pore appearing at the apex, the cavity deep, becoming more shallow as the disc expands; maturing subfleshy, up to 1.1 mm. diam. in the fresh condition, contracting slightly on drying, commonly 0.3–0.6 (–0.8) mm. diam. in dried specimens, sessile; **receptacle** entirely smooth, white when fresh, seated on the substrate by a narrow central portion, pale yellow to ochraceous on drying; **hymenium** creamy-white when fresh, plane to slightly concave, or with maximum moisture varying to strongly convex, drying waxy, pale to dull yellow, variable but commonly near "Ivory Yellow" (R) or "Ochraceous Buff," saucer-shaped; **margin** circular to rarely more or less lobed, smooth when fresh and in mature specimens not elevated, turning upward on drying, smooth or becoming pruinulose; **in section** rather thick over point of attachment, gradually thinner toward the margin, the hymenium 60–70 $\mu$ thick, hypothecium scarcely differentiated, medullary region rather open in structure, composed of thin-walled, septate, interwoven hyphae, grading rather indefinitely into an ectal layer which is rather thick at the base, becoming thinner toward the margin, about 30–50 $\mu$ half-way between base and margin, compact, composed of more or less isodiametric cells, 8–15 $\mu$ diam., thin-walled or the outer ones near the substratum very slightly thickened; **paraphyses** simple, 3–5 septate, very slightly enlarged upward, 3–3.8 $\mu$ at the apex; **asci** clavate, originating from croziers, 50–70 x 6–9 $\mu$, the apex noticeably pointed, the pore bright blue with iodine; **ascospores** biseriate or sub-biseriate, irregularly oblong-fusoid, slightly curved or flattened on one side, 1-celled, 10–13 x 2.7–3.4 $\mu$, the content homogeneous or more rarely with a few small oil droplets.

HABITAT: American specimens on *Amelanchier intermedia* Spach., *Fagus grandifolia* Ehrh., *Platanus occidentalis* L., *Robinia Pseudoacacia* L., *Tilia americana* L., and sp. indet.: European specimens recorded on *Acer platanoides, Castanea vesca, Corylus* sp., *Fraxinus pubescens, Populus canadensis, Populus pyramidalis, Quercus* sp., *Robinia macrophylla,*

*R. Pseudoacacia, Salix alba, S. daphnoides, Tilia* sp., *Ulmus* sp., and sp. indet.

DISTRIBUTION: Specimens studied from Massachusetts, New York and Pennsylvania; not otherwise known from North America. European material examined from Germany, France, and England; not known from elsewhere. Sept. 6–Oct. 9 in N. Y. & Pa., in quantity when found.

MATERIAL EXAMINED: **Mass.:** On racheae & petioles of *Robinia Pseudoacacia*, Wakefield, Oct. 23, 1942, *D. H. Linder* (FH).—**N. Y.:** On beech leaves, Tichener's Glen, Canandaigua, Sept. 7, 1896, *Durand* [as *Helotium phyllophilum*] (CUP-D *916*).—On basswood leaves, Jasin's Gull, Sept. 5, 1902, *Durand*, as *H. punctiforme* f. *Tiliae* (CUP-D *1727*).—On *Amelanchier intermedia*, Lloyd Preserve, McLean, Sept. 6, 1935, *H. H. Whetzel* (CU-P *29137*, FH, BPI).—On decaying leaves sycamore, Cayuta Lake, Sept. 9, 1938, *H. H. Whetzel & W. L. White 3432* (FH).—**Penna.:** On decaying leaves. Sycamore Mills Road, near Media. Oct. 9, 1936. *Whetzel* (CU-P *27978*, FH).—**Europe: Germany:** "An der obern Fläche dürren Blätter von Populus pyramidalis auf der Münchau bei Hattenheim." Herb. Barb.-Boiss. *1217*, **type** of *H. populinum* (FH).—"Ad folia putrida, non raro. Automno. Oestrich (Nassau). leg. Fuckel." [as *Pseudohelotium puberulum*] Herb. Barb.-Boiss. *1220* (FH).—"In foliis Quercus putridis ad Sugenheim Bavariae. leg. Dr. Rehm." Rabenh., Fungi Eur. *1121* [as *Peziza tumidula*] (FH).—"Auf Castanea vesca. Lichterfelde bei Berlin. 9.1888. leg. P. Sydow." Myc. March. *2445* [as *Pezizella tumidula* f. *Castanae*] (FH).—"Auf Corylus-Blättern. Lichterfelde bei Berlin. 9-1890. leg. P. Sydow." Myc. March. *3476*, as *Helotium punctiforme* (FH).—"An Corylus, Ulmus-Blattern. Berlin, Lichterfelde. 10.1892 leg. P. Sydow." Myc. March. *3769* [as *H. phyllophilum*] (FH).—"An Robinia macrophylla. Berlin, Lichterfelde. 10.1892. leg. P. Sydow." Myc. March. *3780*, as *Pezizella punctiformis* f. *foliicola* (FH).—"An Salix alba. Berlin, Lichterfelde. 10.1892. leg. P. Sydow." Myc. March. *3781* as *P. punctiformis* f. *foliicola* (FH).—"An Robinia pseudoacacia. Berlin, Lichterfelde. 10.1892. leg. P. Sydow." Myc. March *3782*, as *P. punctiformis* f. *petiolicola* (FH).—"An Salix daphnoides. Am Wannsee bei Berlin. 10.1893. leg. P. Sydow." Syd., Myc. March. *3960*, as *P. punctiformis* (FH).—"Auf Robinia macrophylla, Lichterfelde bei Berlin. 10.1893. leg. P. Sydow." Myc. March. *4046*, as *P. punctiformis* f. *petiolicola* (FH).—"Faulende Blättern von Acer platanoides. Lichterfelde bei Berlin." 10.1893, *Sydow*, Rehm, Ascom. *1162* [as *P. puberula*] (FH).—"Auf faulen Blattern. Wiener-Wald. 1/X. 1909 v. Höhnel." [as *P. tumidula* Rehm (non Desm.)?] (FH-H).—"Auf faulenden, vorjahrigen Blättern von Populus canadensis Michaux. Prov. Brandenburg: Triglitz in der Prignitz. 8.X. 1909. leg. Otto Jaap." Fungi Sel. Exsicc. *364* [as *Helotium conformatum*] (FH).—"Auf Blättern von Fraxinus pubescens. Brandenburg: Baumschulen zu Tamsel. 25.9.1909. leg. P. Vogel." Syd., Myc. Germ. *902*, as *Pezizella punctiformis* (FH).—On decayed leaves of *Tilia*, Naedaschutz, Saxony, Oct. 6. 1912, *G. Freulich.* as *P. punctiformis* Rehm non Grev. (FH-H).—**France:** "Normandie: Sur de vieilles; Lebiscy pres Caen. Roberge." [as *Phialea phyllophila*] (FH).—"Fol. sicc. Aceris platanoidis, etc. Caen. Coll. Roberge." [as Peziza *lachnobrachya*] (FH-C).—**England:** Carlisle, *Carlyle*, as *Helotium punctiforme* (CUP-D *4198*, NY-M).—Terrington, St. Clement, *C. B. Plowright*, Phill., Elv. Brit. *88* [as *H. epiphyllum*] (FH).—On Holly, Shrewsbury, Phill., Elv. Brit. *134* [as *H. epiphyllum* var. *Illicina* (*nom. nud.*)]. Type of *H. Ilicis* (FH).

Greville's specific epithet of 1824, due perhaps to the fact that it is descriptive of numerous minute species, has become a "dumping ground" for almost any species that might be described as "punctiform." Since it has been the subject of so much controversy and misinterpretation, and since the other specific names included in the synonym are so little known, the following historical sketch seems necessary.

Greville's *Peziza punctiformis* was described from Scotland and said to be on the leaves of *Fagus* and *Quercus*. The essential features of the description are as follows:

"P. yellow, very minute, gregarious, punctiform, globose, at length plane, the margin crenulate.

"Bright yellow but extremely minute, gregarious, globose at first, with a small central opening, at length becoming quite plane, or even slightly convex, the extreme margin very thin and crenulate. The substance of the plant is carnose, and the center rather thick for its size. The whole is glabrous. Sporuliferous cells linear-oblong. Sporules yellow, difficult to be perceived.

"Were it not for a considerable number growing together, this species might escape the eye of a practical mycologist. I have met with it several times and have ascertained its characters to be constant. It not infrequently accompanies *Phacidium coronatum* and *Sclerotium quercinum*."

In Greville's accompanying illustrations the apothecia are gregarious but not crowded and occur on the dorsal surface of an oak leaf, especially scattered in the vicinity of the midrib and the larger lateral veins. They are at first globose with a small distinct central pore and are attached by a fairly narrow central portion. As they expand they are rather fleshy, flattened-globose with a pore and an apparently deeply cupulate central hymenial cavity. The receptacle does not narrow to a stipe or a stipe-like attachment, but rather it narrows gradually from the margin to the central part where it is seated on the substrate. The apothecia are in all stages bright yellow throughout, thick and fleshy for their size, and at certain stages they exhibit a slightly roughened margin.

The interpretation I have placed on Greville's species is that of Rehm, and it is the one that has been general in continental Europe. In favor of this general European interpretation is the morphological similarity of the form to that in Greville's illustration; against it is the fact that of the large number of specimens available none are known with certainty to be on oak leaves, which is the correct substratum for Greville's species.

Finally Von Höhnel considered Greville's species in some detail and rejected the common European interpretation of it. He noted that while Greville's species was described as occurring on both *Fagus* and *Quercus*, and might therefore be a mixed species, yet the apothecia illustrated were on an oak leaf and for this reason we should refer to the species of Greville a form known to occur on oak. Unfortunately, when Von Höhnel applied Greville's name to a form occurring on oak, he chose a species that varied rather conspicuously from that of Greville in its gross morphology. This species is treated in the present paper as number 17, *Helotium puberulum*.

In order to get an idea of the British interpretation of Greville's *punctiformis* I have referred to Massee's herbarium at the New York Botanical Garden. I find there four British entries under that name, and as nearly as can be determined they represent three different species. Only one specimen is there; the other three entries consisting only of notes and

drawings. The specimen is the same as the material referred to *punctiformis* on the continent and is marked by Massee "not the typical form."

In view of the foregoing, Greville's name *punctiformis* should be discarded. It may have been applied originally to any one or more of several minute foliicolous species, and since the original specimen is lost it is unlikely that a non-controversial interpretation could ever be placed upon it.

The material of Herb. Barb.-Boiss. *1217* appears to be part of that on which Fuckel based his description of *H. populinum*. Its apothecia are rather sparse, are only partially opened, and apparently are largely immature. They tend to be more deeply colored — more of a grayish-ochraceous — than most of the later material which I have referred here, but otherwise there is no difference.

Phillips' type of *H. Ilicis*, distributed in his Elv. Brit. *134*, as represented by the specimen in the Farlow Herbarium, is beautiful material showing well developed apothecia on the leaves of *Ilex*. They exhibit the distributional pattern typical for *H. populinum*, that is, they are numerous but more or less unevenly distributed over the leaf surface, tending in places to become gregarious. They occur on both surfaces of the leaf but are predominantly on the under (dorsal) surface. They are fleshy, deep yellow, concolorous on all parts, waxy, and are in all stages of development, the largest sometimes becoming somewhat lobate and a few ranging up to 0.8 mm. in diameter, the hymenium plane, but the margin rather thick and obtuse and elevated above the hymenial surface.

Both *H. populinum* and *H. Ilicis* have been very much neglected, most collections referable here having been identified with *Peziza punctiformis* Grev. or one of its later synonyms. In fact the only record found of the identification of later material with either *populinum* or *Ilicis* is that of a collection made by Seaver and Bethel in Colorado on *Populus tremuloides* in 1910 and reported doubtfully by Seaver as *H. populinum* in Mycologia **3**: 62. 1911. This specimen, kindly loaned the writer by Dr. Seaver, proves to be *Mollisina acerina* (Mout.) Höhn. (Mitt. Bot. Techn. Hochsch. Wien **3**: 67, 104. 1926), and represents the only collection of the species which I have known from North America, although several have been examined from Europe.

The species as here defined appears to be constant and well delimited, the ascospores, especially, presenting a remarkable uniformity in both size and shape.

The following exsiccati and other specimens under names which I have listed in the synonymy of *Helotium populinum* are incorrectly determined and are here reidentified as follows:

Krieg., Fungi Sax. *881* [as *Pezizella punctiformis*] (FH) = *Mollisina acerina* (Mout.) Höhn. — Syd., Myc. March. *4041*, *4042*, *4043*, *4044*, *4045* [as *P. punctiformis* f. *foliicola*] (FH). = *Mollisina acerina* (Mout.)

Höhn. — Spec. in Durand Herb. [as *P. punctiformis* f. *fructicola*] (CUP-D *1315, 1775*) = An unknown species. — Syd., Myc. Germ. *125* [as *P. punctiformis*] = An unknown species. — Spec. reported by Kanouse (l. c.) on elm leaves from Michigan [as *P. punctiformis*] (Mich.) = An unknown species.

**15. Helotium tumidulum** (Rob. ex Desm.) Massee [Fungus Fl. Yorkshire, p. 285. 1905].

*Peziza tumidula* Rob. ex Desm., Ann. Sci. Nat. 3: **16:** 325. 1851. — Str., Nom. Fung. p. 437. 1862.

*Pezizella tumidula* (Rob. ex Desm.) Sacc., Syll. Fung. **8:** 276. 1889. — [Rehm *in* Rabenh. Krypt.-Fl. **1**[3]: 650, *fig. 1–5*, 666. 1893.] — Von Höhn., Sitz.-ber. Akad. Wien. Math.-nat. 1: **127:** 599. 1918. — Mitt. Bot. Inst. Techn. Hochsch. Wien **3:** 72. 1926. — [Vel., Monogr. Discom. Bohem. **1:** 160; **2:** *pl. 11, fig. 54.* 1934.] — [Kanouse, Papers Michigan Acad. Sci. **19** (1933): 96. 1934.]

*Mollisia tumidula* (Rob. ex Desm.) Höhn., Sitz-ber. Akad. Wien, Math.-nat. Kl. 1: **115:** 1284. 1906.

*Hyalinia tumidula* (Rob. ex Desm.) Boud., Hist. Classif. Discom. Eur., p. 104. 1907.

*Hymenoscypha tumidula* (Rob. ex Desm.) Kuntze, Rev. Gen. Pl. 3[2]: 487. 1898. — [Migula *in* Thomé's Krypt.-Fl. **10**[2]: 1153, *pl. 173, fig. 5–8.* 1913.]

FIGURE 15.

**Apothecia** scattered or subgregarious, not crowded, erumpent, sessile, minute, white when fresh (Desm.), in the dried condition gelatinous-cartilaginous, dilute ochraceous, about the same color as the leaves on which they occur, rising only slightly above the leaf surface, cushion-shaped with a slightly concave hymenium, not over 0.2 mm. diameter; on moistening becoming thick, showing a tumid excipulum and a slight, thick, lacerate margin raised above the hymenium; **paraphyses** more or less adherent to each other, not staining, strongly enlarged at the apex to 4–5 $\mu$ diam.; **asci** subcylindric, the pedicel short, thick, the apex noticeably narrowed then truncate, the pore bright blue in iodine, 40–46 x 8.5–9.2 $\mu$, originating from croziers which are obscure; **ascospores** oblong, slightly inequilateral, biseriate in the ascus, 12–13 x 2.8–3.3 $\mu$, the ends rounded, the content homogeneous or with a small amount of granular material in each end, always 1-celled.

HABITAT: Apothecia on the parenchyma of dead leaves of *Betula* sp. Reports of its occurrence on other species are in error.

DISTRIBUTION: France. Known only from the material of Desmazières.

MATERIAL EXAMINED: "Au printemps, sur les deux faces des feuilles à demi-pourries du Bouleau." Desm., Pl. Crypt. Fr. ed. 1, *2011;* ed. 2, *1611* (FH, FH-C).

The original material of this species is very ample and in good condition. The apothecia in the dried condition, especially at maturity, are not strongly raised above the leaf surface and are rather thin. The excipulum protrudes beyond the margin of the hymenium and turns inward, lying close to and entirely obscuring the ascus layer. When viewed in the dried condition only the enclosing excipular tissue is seen,

plus some slight evidence of a central pore or depression. On moistening the margin becomes erect and appears rather thick and lacerate and is elevated above the central hymenial cavity.

Though several workers since the time of Desmazières have referred material to this species, there is no evidence that anyone except Von Höhnel has made a critical examination of the type. Most, if not all, of this later material so referred has been wrongly identified. The history of the species follows briefly:

Saccardo (1889) transferred it to *Pezizella* but suggested the genus *Cyathicula* for it because of its lacerate margin. This was entirely on the basis of the original description. Rehm treated it in 1893, reporting it from two localities in Germany, and listing decaying leaves of *Quercus* as the substrate. It is certain, as shown later by Von Höhnel, that Rehm did not have the Desmazières species. Massee (1905) reported it on oak leaves from two localities in England and transferred it to *Helotium*. These collections may be in the Massee herbarium at the New York Botanical Garden but I have not seen them. There is scarcely a possibility that they are correctly identified. In 1906 Von Höhnel published a fairly good redescription based on the Desmazières type and transferred the species to *Mollisia*. He also noted that Rabenh. *1121*, which was cited by Rehm, and which was partly, if not wholly, the basis of Rehm's conception of *tumidula*, did not agree with the type and should be the basis of another species which he would call *Pezizella tumidula* Rehm non Desm. He further noted that Syd. Myc. March. *1853* distributed as *Helotium tumidulum* was not in agreement with the type. In 1918 he again noted that *tumidula* had not been used in its correct sense by Rehm, and following up this in 1926 he referred *tumidula* sensu Rehm to what he called the true *Peziza punctiformis* of Greville and made *punctiformis* the basis of a new genus *Calycellina*. In 1934 Velenovský reported *tumidula*, obviously in error as indicated by his drawings, from Czechoslovakia on *Quercus*, *Fagus*, and *Carpinus*.

Rehm's interpretation of *tumidula* is confused. Since he mentions at least two different collections it is possible that he was working with two — or possibly more, species. The one specimen which he cites specifically (Rabenh., Fungi Eur. *1121*) is, as indicated by the specimen in the Farlow Herbarium, closely allied if not identical with *Helotium populinum*. It agrees perfectly with *populinum* in the characters of its paraphyses, asci, and spores; it differs however in that the apothecia are smaller, are much thinner and more closely adherent to the substratum, in the dried condition are translucent-ochraceous and cartilaginous, and in its occurrence on oak leaves. It is strongly suggestive of *H. lucellum* (Karst.) Karst., of which I have not been able to get authentic material for comparison. On the other hand, the spore characters indicated by Rehm for *tumidula* — which may or may not have been taken from the Rabenhorst specimen — are not those of *populinum*, but

could represent either *lucellum* or *puberulum*. A slide in the Von Höhnel herbarium made from Rabenh. *1121* shows spores of *lucellum* or *puberulum* — not *populinum*. It appears then that Rabenh. *1121* might be a mixture of two species, one of which is *puberulum* (or *lucellum*). This would account for Von Höhnel's reference of *tumidula* sensu Rehm to synonymy under *punctiformis*, the latter as Von Höhnel understood it, but not according to the treatment of others which is accepted in this paper, actually representing *puberulum*.

The single North American specimen (on oak leaves in Michigan) that has been reported as *tumidula* is incorrectly determined and represents a species which I am unable to name. Those available from Europe are all wrongly determined and are here reidentified as follows:

Rabenh., Fungi Eur. *1121* (FH) = An atypical specimen of *H. populinum* or a closely related form. — Syd., Myc. March. *1853* (FH) = A mixture of *Mollisina acerina* (Mout.) Höhn. and *Hyaloscypha lachnobrachya* (Desm.) Nannf. — Syd., Myc. March. *2444, 2445* (FH) = *Helotium populinum* Fuckel. — Syd., Myc. March. *2446* (FH) = *Hyaloscypha lachnobrachya* (Desm.) Nannf. — Spec. in Von Höhnel Herbarium [as *Pezizella tumidula* Rehm (non Desm.) ?, Wiener-Wald, 1/X.1909 = *Helotium populinum* Fuckel.

**16. Pezizella glagosa** (Ell. & Ev.) Sacc., Syll. Fung. **8**: 276. 1887.

*Peziza glagosa* Ell. & Ev., Journ. Myc. **4**: 56. 1888.
*Hymenoscypha glagosa* (Ell. & Ev.) Kuntze, Rev. Gen. Pl. **3**$^2$: 485. 1898.

FIGURE 16.

**Apothecia** minute, numerous, evenly distributed and not crowded, sessile, thick, white or whitish when fresh, reaching a maximum diameter of 325 $\mu$, drying concolorous with the substrate surface and not visible to the naked eye; **receptacle** smooth, when fresh translucent-brownish, the sides nearly vertical from substrate to margin, slightly constricted at point of attachment, contracting on drying and becoming more or less turbinate, darker in color, shiny; **hymenium** in fresh condition white, convex, drying plane or slightly concave, brown, shiny; **paraphyses** noticeably thin, once forked below the middle and again at the apex, the apices 2 $\mu$; **asci** clavate, originating from croziers, 70–75 x 7–8 $\mu$; **ascospores** biseriate, inequilaterally oblong or oblong-fusoid, 2-celled, 11–13 x 3.2–3.9 $\mu$, the ends obtuse.

HABITAT: On decaying leaves of *Nyssa sylvatica* Marsh.

DISTRIBUTION: Massachusetts (Nantucket) and New Jersey. August.

MATERIAL EXAMINED: **Mass.**: Madaket, Nantucket, Aug. 17, 1942, *E. V. Seeler* (FH). — **N. J.**: Newfield, 7 Aug. 1887, *Ellis*, **type** (CUP-D *8706*, FH-E).

The species is known only from these two specimens. Though the host of the type material had never been determined, it appears by comparison to be the same as that of the Nantucket specimen.

The affinities appear to be with *Helotium populinum* and *H. tumidulum*.

FIGURES 10–17.

It has not, however, had a combination in *Helotium* and there can scarcely be any gain in making one for it, since in any disposition of these species which even remotely approaches finality none of them could be left in *Helotium*.

**17. Helotium puberulum** (Lasch ex Rabenh.) Fuckel, Fungi Rhenani *1150*. 1864.

*Peziza puberula* Lasch ex Rabenh., Flora **34**: 583. 1851; non Berk. & Curt. Grevillea **3**: 155. 1875. — Str., Nom. Fung., p. 432. 1862.

*Pseudohelotium puberulum* (Lasch ex Rabenh.) Fuckel, Symb. Myc., p. 298. 1869. — Sacc., Syll. Fung. **8**: 300. 1889.

*Lachnella puberula* (Lasch ex Rabenh.) Phill., Grevillea **18**: 85. 1890.

*Pezizella puberula* (Lasch ex Rabenh.) Rehm *in* Rabenh., Krypt.-Fl. $1^3$: 665. 1893. — [Rehm, Hedwigia **35**: 146. 1896.] — [Kanouse. Papers Michigan Acad. **19** (1933): 96. 1934.]

*Dasyscypha puberula* (Lasch ex Rabenh.) Massee, Brit. Fung.-Fl. **4**: 355. 1895.

*Belonium sulphureo-tinctum* Rehm, Hedw. **35**: 146. 1896. — Sacc., Syll. Fung. **14**: 785. 1899. — Jaap, Verh. Bot. Ver. Prov. Brandenburg **52**: 5. 1910; **57**: 9. 1915.

*Urceolella puberula* (Lasch. ex Rahenh.) Boud., Hist. Classif. Discom. Eur., p. 129. 1907.

*Niptera sulphureo-tincta* (Rehm) Boud., Hist. Classif. Discom. Eur., p. 141. 1907.

*Hymenoscypha puberula* (Lasch ex Rabenh.) Migula *in* Thomé's Krypt.-Fl. $10^2$: 1151. 1913.

*Peziza punctiformis* auct. — Von Höhn., Sitzb. Akad. Wissensch. Wien, Math.-nat. Kl. 1: **127**: 601. 1918.

*Calycellina populina* auct. — Von Höhn., Sitzb. Akad. Wissensch. Wien. Math.-nat. Kl. 1: **127**. 601. 1918. — Von Höhn., Mitt. Bot. Inst. Techn. Hochsch. Wien **3**: 105. 1926.

*Phialina puberula* (Lasch. ex Rabenh.) Höhn. [Mitt. Bot. Inst. Techn. Hochsch. **3**: 106. 1926]. — (Under *Hyaloscypha*) Nannf., Nova Acta. Soc. Sci. Upsal. 4: $8^2$: 273. 1932.

FIGURE 17.

**Apothecia** rather numerous on localized areas of the leaf surface, sometimes crowded in groups of 5–15 with occasional solitary ones scattered beyond these groups, very small, appearing sessile but actually with a short obscure stipe, the disc 0.1–0.4 (–0.7) mm. diam., when fresh bright lemon-yellow, not contracting or changing color perceptibly on drying, all parts concolorous; **stipe** very short, thin, delicate, not perceptible unless fruit body is removed from substrate and inverted; **disc** turbinate at first, finally spreading and thin, more so on drying; **receptacle** very finely puberulent, often finely radiately striolate, lying against the substratum in the older ones, sometimes becoming pale yellow or buff on drying or after several years in the herbarium; **margin**

**Fig. 10–17: 10,** *Helotium albopunctum,* from type (CUP-D *5915*); **11,** *H. phyllogenon,* from Rehm's Ascom. *768,* type (FH); **12,** *H. phyllophilum,* from spec. in Desm., Pl. Crypt. Fr. *1159,* type (FH); **13,** *Phialea Cassandrae,* from spec. cited (MICH); **14,** *Helotium populinum.* from Herb. Barb.-Boiss. *1217,* type (FH); **15,** *H. tumidulum.* from spec. in Desm., Pl. Crypt. Fr. *2011,* type (FH); **16,** *Pezizella glagosa,* from type (CUP-D *8706*); **17,** *Helotium puberulum,* from spec. Rabenh., Kl. Herb. Myc. *1529,* type (FH). All drawings × 1290.

not elevated, rarely becoming very slightly so on drying, circular to irregular or angular in outline; **hymenium** convex in the fresh condition and bright yellow, on drying becoming plane, waxy, remaining yellow, or in old herbarium specimens changing to pale citron to pale orange; **paraphyses** rather stout, scarcely or not at all enlarged at the apex, 3–3.5 $\mu$ diam.; simple or more rarely once branched near the base; **asci** originating from croziers, short, clavate, 38–54 x 6.5–8 $\mu$; **ascospores** biseriate or irregularly crowded, elongate, straight or slightly irregularly curved, sometimes somewhat irregular in outline, 1-celled, 12–18 x 1.8–2.6 $\mu$, the content homogeneous or more frequently with several small oil globules in each end.

HABITAT: On decaying leaves of *Quercus* sp., rarely on other genera; in the Nantucket collection cited below a few apothecia are on a leaf which appears to be *Vaccinium* sp., and Thüm., Myc. Austr. *930* is said, evidently correctly, to be on *Carpinus* sp. Reports in European literature of its occurrence on leaves other than *Quercus* probably are for the most part incorrect.

DISTRIBUTION: New Hampshire, Massachusetts, New York, Germany, Czechoslovakia, and France; reported from England and perhaps other European countries but material not examined. Oct. 3–Nov. 11 in N. Am.

MATERIAL EXAMINED: **North America: N. H.:** Gilmanton, Oct. 12, 1942, *D. H. Linder* (FH). — **Mass.:** Nantucket, Oct. 12, 1941, *E. V. Seeler* (FH). — East side of Great Blue Hills, near Milton, Nov. 11, 1941, *D. H. Linder & E. V. Seeler* (FH). — Another collection of same locality, etc. *W. L. White* (FH). — **N. Y.:** Coy Glen, near Ithaca, Oct. 3, 1938, *Whetzel, White, et al* (FH). — **Europe: Germany:** "Ad folia decid. acervata Quercus pr. Driesen." Rabenh., Kl. Herb. Viv. Myc. *1529*, **type** of *Peziza puberula* (FH). — "An faulenden Eichenblättern, Zehlendorf bei Berlin. 10.1892." *Sydow.* Rehm, Ascom. *1158*, type of *Belonium sulfureo-tinctum* (FH). — "An Blättern von Quercus Rober, Triglitz (Prignitz). Jaap." Rehm. Ascom. *1158b*, as *B. sulfureo-tinctum* (FH-H). — "An Quercus-Blattern, Berlin, Lechtindorf, 10.1892, leg. P. Sydow." Syd., Myc. March. *3778*, as *B. sulfureo-tinctum* (FH). — "An foliis Quercus coccinea, Tamsel bei Custria, Mark Brandenburg. 10.10.1906. leg. P. Vogel." As *B. sulfureo-tinctum* (FH-H). — ". . . auf Quercus Rober L. bei Konigstein. Oct. 1910. leg. W. Krieger." As *Helotium punctiforme* (Grev.) v. H. non Rehm sub *Pezizella* (FH-H). — **Czechoslovakia:** "Bohemia sept.: Teplitz ad folia putrida Carpini, vere 1872 . . ." Thüm., Fungi Austr. *930*, as *Pseudohelotium puberulum* (FH). — **France:** "Ad folia Quercus. 13 Oct. 1849. Sent by Roussel." [as *Peziza punctiformis*] (FH-C).

The following specimens under names listed in the synonymy above represent incorrect determinations: Herb. Barb.-Bois *1220* [as *Pseudohelotium puberulum*] (FH) = *Helotium populinum* Fuckel. — Rehm., Ascom. *1162* (FH) [as *Pezizella puberula*] (FH) = *Helotium populinum*. — Spec. taken on oak leaves at Ann Arbor, Michigan, Oct. 21, 1928, and reported by Kanouse (l. c.) as *Pezizella puberula* (FH) = *Mollisina acerina* (Mout.) Höhn.

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